

Engineering Record

A Weekly Journal Devoted to Civil Engineering and Contracting

PUBLISHED BY MCGRAW PUBLISHING COMPANY, INC.

Volume 71

NEW YORK, SATURDAY, JUNE 26, 1915

Number 26

New York's New Subways in Operation

THAT two parts of the new dual subway system of New York City were opened this week illustrates the progress that has been made in the great construction undertakings that are to more than double rapid transit facilities within the city. Both lines connect Brooklyn more closely with Manhattan. One will deliver passengers on transfers from the Grand Central station of the old subway to the surface and elevated lines of Long Island City. The other route extends from the Municipal Building across Brooklyn to Coney Island, via the Manhattan Bridge and Fourth Avenue. Both routes were proposed, construction on them started and one actually built before the dual system was planned. Much credit is due the Public Service Commission for welding these routes into an operating system connected with existing routes and with the new lines necessary to the city's expansion, and also for taking prompt advantage of the previous start made on these lines to operate them without waiting for the entire system to be built.

Continued Sand Testing

IN THIS ISSUE is concluded a series of articles on sand analysis by Cloyd M. Chapman and Nathan C. Johnson. The Engineering Record believes that its prediction that the articles would be of the highest excellence has been borne out by the series. The necessity of sand analysis, its possibilities for securing economies for the contractor and a superior product for the owners, the characteristics of sands, due to their origin, which influence their field of usefulness, were discussed in the first two articles. The third describes the tests briefly and then drives home the very important doctrine of the necessity of continuing the analysis of sand throughout the job, just as every shipment of cement or every rolling of reinforcement bars is tested. This need of continued testing was shown in the first article, but its importance is such that too much emphasis cannot be placed upon it. To rely on a single test before the job is started or in the early stages of the work has no more logic to support it, when applied to sand, than would a single test for cement. Failure to appreciate this point has been due to the belief that "sand is sand," but now that the fallacy of this phrase has been shown, it should need no argument to convince engineers, particularly, that continuous sand testing is necessary. Contractors may be more difficult to win over, but they can be made to see the light from the angle presented in the first article of the series referred to. One final word: It avails

but little for engineering progress if engineers assent to the conclusions reached in this series but fail to act, if they commend sand testing but do not put it to practical use. Between conviction and action there should be no lapse. If sand testing is good, specifications should be revised to accord with modern conceptions and examination of the material continued as the shipments come in or as new sections of bank are uncovered. Any less positive action means a continuance of the present inadequate and unscientific methods of controlling one of the most important elements in the making of concrete.

Schoolboy Sanitarians

COMMANDERING school children to do inspection work that should be performed by city officials is not a new idea, but the scale on which the Civic-Industrial Clubs of the Chicago high-schools carried out a sanitary survey of 2225 blocks is worth noting, for it has been given official recognition, the results have been turned into the street department and a certain amount of cleaning up will surely follow. The survey covered a district larger in population than Milwaukee and included such factors of sanitation as garbage cans, vessels for miscellaneous waste and ashes, stables and manure vaults, the removal of all wastes, paving conditions and littering of alleys, conditions of yards and vacant lots. To get the work done the area assigned to a school was divided into twenty-block districts with a captain and team assigned to each district. A tabulation committee concentrated the work of the captains into separate summary sheets for garbage, ashes, stables, vacant lots and alleys so that the reports might be referred to different bureaus of the city. In some cases maps, colored to indicate conditions, were made. There is no doubt that the really great benefit from this work will come through the intimate knowledge of backyard conditions obtained by the boys in their own neighborhoods. A representative of this journal once undertook to clean up the mosquito breeders in a suburban town of 2500 people and found backyard conditions so unbelievably bad in what was supposed to be an enlightened community that his photographs were the only means of saving his reputation for veracity when an appeal was made to the local improvement club for financial and moral support to help clean up the town. Children tell the truth and the Chicago city fathers would do well to clean up the unsavory districts. The blame will now be placed where it belongs, for the boys are to continue further systematic work along the same lines.

To Alaska by Rail

NO PROJECT for an all-rail route to Alaska is known to be under consideration at this time, but there have been rumors of such a connecting link. The Pacific Great Eastern Railway, which runs 478 miles north from Vancouver, is now nearing completion, as noted elsewhere in this issue, and it is interesting to observe that before it was well under way the decision was made to extend it to the north beyond its intersection with the Grand Trunk Pacific Railway at Fort George. This extension is to follow a northerly direction for some distance beyond Fort George and will then turn eastward, cross the Rocky Mountains and run to the eastern border of the province in the Peace River Valley. It is true that the latter extension is primarily to encourage the development of the agricultural and mineral resources of adjacent territory and does not even follow the most direct route toward the Government railroad system in Alaska. However, the completion of the Pacific Great Eastern will provide a direct north and south route from Salina Cruz, Mexico, in latitude 16 north, to a point north of the fifty-fifth parallel, or about 500 miles north of Vancouver as the crow flies. This makes the total length of the continuous railroad that roughly parallels the coast, only 6 degrees less than half the distance from the equator to the North Pole. By the most direct land route, there is still a gap of over 900 miles that must yet be spanned before the all-rail connection with the Government railroad in Alaska is realized, but the Engineering Record has already reported joint consideration of the feasibility of constructing such a road by Premier McBride of British Columbia and Secretary of State Lane. The spanning of this gap is certain to come in time, and, perhaps, much sooner than most of us expect.

Essence of Modern Organization

OCCASIONALLY one comes across a paragraph or a sentence that expresses the essence of an important situation or otherwise condenses thoughts that normally are of large compass. Such a paragraph, stating tersely the type of management which business and military organizations have found to stand the most severe test, is contained in an article on "Business Efficiency and Its Application to Public Affairs," written by Elihu C. Church, formerly chief of the Bureau of Supplies of the Department of Water Supply, Gas and Electricity, New York City, and published in the July number of the *Bulletin* of the New York Real Estate

Board. So striking is the expression that it is here reproduced. It will start a train of thought in the mind of every one concerned with organization problems to bring back vividly the principles, at least, underlying what we have learned of modern methods of management in recent years, and to tempt one to apply it to his problem as a standard by which to judge of the sufficiency of his own organization.

"The executive," Mr. Church says, "is charged with the supervision of two distinct classes of work. One involves planning, the other execution. They are entirely unlike and call for different treatment. The importance of planning is gradually increasing as undertakings grow in size and ever tend to become more and more complicated. *It is now recognized that achieving success is essentially a thinking job.* But who is to attend to all this investigation and study? The man on the firing line has not the time. Yet if a business, like an individual, is going to 'make its head save its heels' there must be men specifically charged with the task. Such men are said to belong to the 'staff' or directing branch of industry, as contrasted with the 'line' officials, who comprise that part of the organization which carries on the work at first hand, exercising authority, maintaining discipline, and getting the day's work done."

The quotation deserves to be clipped or copied by every man and placed where it will frequently come to notice, in order that it may serve to emphasize in every organization the need for planning and for separating this work, in its larger phases, from execution.

Planning on Contract Work

THE preceding note, emphasizing the necessity in complicated businesses of the separation of the planning and the executive functions, prompts the inquiry whether or not the contracting business is not sadly deficient when judged by such a standard. At the very outset it must be admitted that there are many deficient contracting organizations where adequate attention is given to planning. Such, for example, are some of the very large organizations with ample backing, manned not by men placed there by financiers as actual managers of a business venture, but by hard-headed, shrewd contractors who have risen with or without college education, through the school of hard knocks. Such, also, are some of the very small organizations, where the owner takes but one job at a time and lives on it. In these small organizations, however, there is less likelihood of the separation of the planning and doing functions, though the planning is properly provided for.

Taken in the mass, however, contracting organizations are weak on the planning side. On small jobs the weakness is called ignorance of the contracting "game"; on the big ones, lack of efficient management. Analyzed, however, it will be found that the deficiency is the fundamental one of lack of thinking—of being too busy doing

the work to spend any time in anticipating problems and providing in advance for their solution.

Recently two striking instances of brain versus brawn have come to the attention of this journal. Contractors of two types are working side by side on jobs presenting similar difficulties under identical conditions. In the one case the structure being built is of a very complicated nature. The one contract is going ahead in a rapid, orderly way, the men moving about with an assurance which indicates that they know what they are doing and how to do it. In every department of the work the orderliness and vigor of the activity is evident. On the adjoining contract paralysis in certain phases of the work is evident. Here, equipment is lacking; there, materials (though the job has been in progress six months). In another place men have been withdrawn for no apparent reason. The one job looks ship-shape, successful; the other, disorderly, almost hopeless. Even the layman ignorant of construction methods would declare the one job efficient, the other inefficient. The very atmosphere of the two tells the story. The successful organization is manned by old-time contractors, with a reputation for carrying through difficult jobs successfully. The other is a business venture by financiers knowing nothing of contracting but placing their faith in energetic men whose management is of the brawn rather than of the brain type.

In the other case the adjoining contracts are on railroad grading. In fact, there are half a dozen contractors doing similar work, yet one of them, month after month, gets out one-third more yardage with his steam shovels than any of his competitors. The contractor is noted among his acquaintances as a clear thinker who never tires of developing new methods of attack, who is as "long" on thinking as he is on vigor of execution.

Every contractor and engineer can multiply instances of this sort. There will be those who claim that contract work, on the whole, is conducted quite as efficiently as other lines of business. This journal, however, has indicated its disagreement with these critics and knows that an impartial inquiry will show that its position is correct. As it has pointed out, contracting, fundamentally is more difficult to handle efficiently than a factory. In the latter there is endless repetition of operations capable of being divided into small parts. For this reason it is economical to spend a great deal of time in studying the machines and the methods for each of these operations, for the slight saving on each unit makes a tremendous volume in the aggregate. Furthermore, in factory work operations may readily be supervised closely. On contract work the very opposite conditions obtain. There is comparatively little repetition, and such as there is, is divided into relatively large elements, such as the placing of a whole floor of reinforcement, the erection of thousands of square feet of forms, etc. Again each single manual operation entering into contract work is not often enough repeated to enable it to be stand-

ardized with the thoroughness of factory work, while, evidently, supervision is much more difficult. There enters, too, the element of fatigue, far more serious on contract work, because of the rather strenuous character of the manual operations and less serious in factory operation. All of these points tend to make it more difficult to secure as high an efficiency in contract work as in factory operation, and this fact, sensed unconsciously by contractors, has deterred them from the refinement whose merit the factory manager never questions.

A corollary to these observations is that the opportunity for improvement in the efficiency of contract work is still very large. Higher efficiency is to be obtained by increasing the percentage of thinking—of planning—and decreasing the percentage of jobs on which the doing is considered to render thinking impossible.

A State Society's Experiment

DURING the spring the Connecticut Society of Civil Engineers made an experiment that may well be tried by other State engineering societies. It has been felt that the established meetings do not give the members sufficient opportunity to become acquainted. The constitution provides for an annual meeting in February and one other meeting later in the year. At the annual meeting the regular order of business and the presentation of technical papers give little opportunity for exchanging ideas and meeting new members. The second meeting, usually held in August, is devoted to an excursion to some engineering work of interest. This afforded a somewhat greater opportunity than the annual meeting for getting acquainted, yet the criticism was frequently made that the enjoyment of new members was hampered greatly because they knew few of the members present.

The idea of holding smokers in the larger cities of the State was then conceived, thus bringing the members into closer touch with one another and affording an opportunity of discussing methods of extending the influence of the society and enabling it to better the engineering profession throughout the State. Three meetings were held in accordance with this plan, one at New Haven, one at Hartford and one at New London. The attendance, largely local, of course, was quite satisfactory, and in addition to resulting in new applications for membership showed a very evident increase in interest in the society on the part of the younger members. The meetings were thrown open to a general discussion of matters of interest to engineers, particularly those of a non-technical character. In this way an insight was gained into the broader questions affecting the profession in the State. While it is yet too early to draw conclusions as to the experiment, there is no doubt, according to Frederick Jackson, secretary of the society, that it has resulted in an increase in interest and a strengthening of the society. Just how far it may result in bringing about unity of action by the engineers of the State at large remains to be seen. The

smokers have, however, afforded a common ground where the older and younger members could meet, free from the authoritative restrictions of office and field. The idea is in line with the suggestion made in this journal in January that district organizations be formed within the American Society of Civil Engineers and that district meetings be held, thus giving members of a given locality an opportunity to become better acquainted. While Mr. Jackson, in commenting upon the plan, has been quite conservative, it is apparent that it has inherent excellences which are sure to develop and bear fruit as the plan is continued. If the opportunities of these smokers are realized, they will redound to the benefit of the Connecticut society and put it in a position quickly to wield a greater influence on State affairs of an engineering character. Other State societies may well consider similar schemes.

Long-Span Continuous Trusses

THE new bridge to be erected over the Ohio River at Sciotoville, described on page 799, not only exceeds all previous riveted spans in length of trusses—1500 ft. from end to end supported on three piers—but is unique in several other features. The adoption of the continuous type was based not alone on economy, though it is claimed that the 26,000,000 lb. total weight is less by at least 3,000,000 lb. than any simple span type of construction, but also on the desire for stiffness and rigidity. As nearly all members are subjected to reversal of stress, stiff members with riveted rather than pin-connected joints were adopted, in spite of the fact that very high stresses are to be transmitted at the joints of such a double-track span.

The secondary stresses induced by rigid joints have been carefully investigated and found to be relatively of little more importance than secondary stresses resulting from friction on the large pins required for such joints. Further, the secondary stresses due to dead load are to be practically eliminated by the method of erection. It is claimed that the new type of U-section floorbeam will be both more economical and of greater rigidity, and hence require less maintenance. The direct transfer of tractive forces to the main trusses by horizontal bracing at each panel point is also worthy of note.

In the final selection of type of structure the particular nature of the profile at the crossing, the clear opening required during erection, and the nature of the foundations at possible locations of piers or abutments are all determining factors. The advantages in erection and the fact that solid-rock foundations were found at small depths, so that the settlement at the piers should be practically negligible, were the most important considerations in the selection of the continuous type in this case. Economy for this type can generally be easily shown, but a word of caution against its use for relatively short spans and on foundations where settlements may be large is necessary, since large unforeseen

stress variations would result from relatively small settlements.

The essentially indeterminate character of the stress analysis is also generally considered a disadvantage. The experience with the Queensborough bridge may be cited in this connection. This continuous span on many supports was shown by the reports of the investigating engineers to be designed with astonishing errors in the distribution of the metal, certain members being largely over-stressed, and others much understressed. It is notable, however, that methods of treating indeterminate structures are now becoming well standardized and should soon be simplified into such form as to make the cost of designing low. The use of continuous trusses and of such devices as U-section floorbeams and bracketed swaybracing of this indeterminate type may then become more general if the advantages claimed for them are actually realized in the new span during construction and under service.

Elimination of Odors at New York's Garbage Plants

IN his report on the elimination of offensive odors at the privately operated Barren Island garbage reduction plants in New York City, made public this week, Irwin S. Osborn presents to the Board of Estimate and Apportionment the results of what are claimed to be the most complete tests ever undertaken in this specialized field, and places on record for the first time facts which should be helpful in solving one of the most troublesome municipal problems of to-day. One portion of the report suggests new methods of handling the prime cause of nuisance—the offensive gases from digester tanks. In these containers, of which there are 172 at the works of the New York Disposal Corporation, the garbage is steamed for a period of from 6 to 10 hours under a pressure of 80 lb. per square inch. The tanks are provided with vent lines leading, first, through water-jet condensers where the soluble gases are removed. The insoluble gases, the chief trouble makers, are trapped and discharged into the boiler furnaces, whence they pass, with the other products of combustion, to the stack.

The theory upon which the design of reduction works has been almost universally based is that the heat of the furnace deodorizes the noxious, insoluble gases from the digester tanks, and therefore makes their discharge into the atmosphere permissible. Mr. Osborn's latest tests, however, refute the correctness of this assumption. His investigations have demonstrated that the odors are not eliminated but actually become more irritating as the temperature to which they are subjected increases to a point as high as 2000 deg. Fahr. This condition is explained by the fact that the heat changes the sulphur compounds to sulphur dioxide.

Obviously this is a finding of far-reaching importance. But the tests demonstrated, further, that the sulphur compounds, after undergoing heat, become soluble in water—

another significant finding. Mr. Osborn, therefore, recommends the abandonment of the present practice of discharging the insoluble gases into the boiler furnace and thence directly to the atmosphere. No attempt was made, he states, to suggest the details of any changes in the present design of the plant, although it is to be inferred that any alterations will embody some plan whereby the digester gases, after passing through the preliminary condenser and being subjected to heat, will be treated by a final scrubber in which water sprays will intercept the sulphur component—rendered soluble by heat—which is causing so much trouble under present methods of operation.

These findings relating to the digester gases explain only one of the causes of nuisance at Barren Island. It was discovered that leaks from the digester tanks, which are operated with steam under 80 lb. pressure, are important offenders, and that the waste gases from the dryers must be deodorized if nuisance is to be prevented. These are the three principal causes of odors which may be considered as other than local.

Of course no garbage plant, no matter how well designed, will live up to expectations if it is not operated intelligently. Mr. Osborn makes a strong plea for proper operation and, incidentally, points out the fallacy of short-term operating contracts, a subject whose importance Commissioner John T. Fetherston fully realized when he recently prepared a bill embodying the long-term contract feature but which, apparently, did not make such a forceful appeal to Governor Whitman, who vetoed the measure.

It is to be regretted that Mr. Osborn does not discuss in fuller detail the remedies for the conditions which he has discovered at Barren Island. He is definite, however, in the assertion that all of the offensive gases can be deodorized with proper treatment, and possibly this phase of the subject will be amplified in a later report. From Commissioner Fetherston it is learned that the New York Disposal Corporation is proceeding to install new apparatus. It is clear that the operation of the plant without creating nuisances will be more costly than under present conditions but public opinion demands measures which will relieve conditions which menace health and destroy real estate values within a considerable radius of the present works.

There is another important lesson in the improvement of the Barren Island works. It is one of co-operation among citizens, the plant operating corporation and municipal departments. The work of investigating conditions was the outcome of a suit brought against the plant operators by the Department of Health after numerous complaints had been made. If the litigation had proceeded to a stage where the courts had ordered the closing of the works New York would have been without adequate means of garbage disposal except dumping at sea. By attacking the problem in a scientific way, with investigations by engineering specialists instead of by aldermanic committees, a satisfactory solution is, apparently, to be realized.

One Huge Single-Lift Lock at Louisville Will Guard the Entrance to the Portland Canal

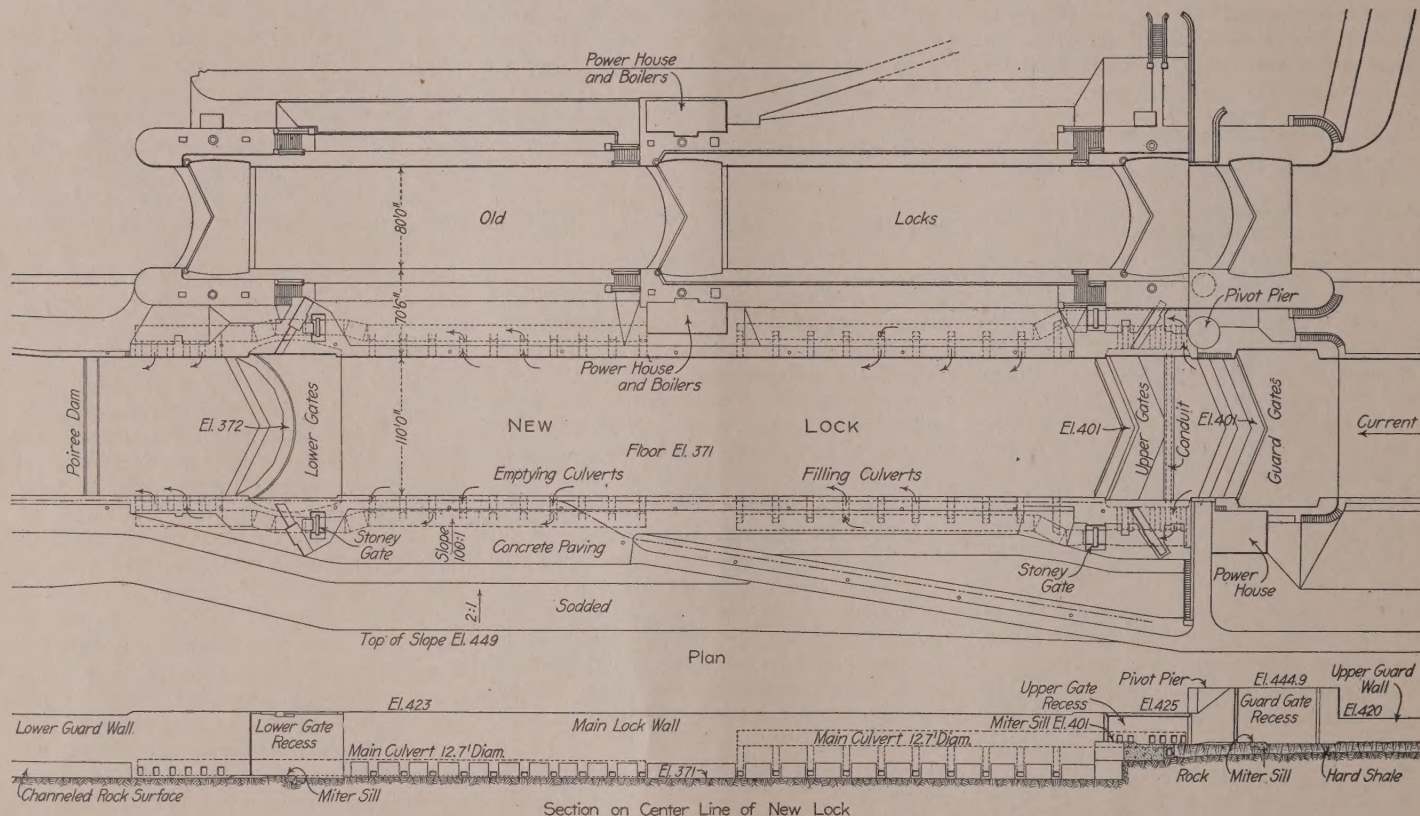
Walls Are Built to the Full Height of 53 Feet Behind Forms Supported by a Mounted Structural-Steel Frame—Ledge of Hard Rock Makes Drilling Arduous

IN ANOTHER YEAR Ohio River Lock 41, at Louisville, will be completed and the canal by the "Falls of the Ohio" will be widened to 200 ft., so that convoys of coal fleets will not need to be broken up into smaller units than three in line and four abreast. One lock of standard Ohio River plan dimensions, 110 x 600 ft., will supplement the two existing structures which enable shipping to pass through the

locks for September, 1914. Notes on the design are taken from that article, but the wall-construction methods were obtained by a recent visit to the work.

The lock is 110 ft. wide and 681 ft. long between quoins, giving an available length of 600 ft. It has a lift at low water above and below of 27 ft.; with the present dam up, a lift of 27 ft., and with the proposed new dam up, a lift of 40 ft. The lower

The butterfly gates are of the standard Ohio River type, but had never been used at so high a head, and it was feared that they would slam and be injured. Also, if they should suddenly open to full capacity the commotion due to the inrush of water might sink vessels. Furthermore, extensive damage would take place if an inlet and outlet gate should be injured and remain open at the same time. On account



NEW LOCK 41 AT LOUISVILLE IS AS LONG AS THE OLD PAIR OF LOCKS ALONGSIDE, AND IS 30 FEET WIDER

2 1/7-mile Portland Canal by the falls which are caused by an outcropping limestone ledge. In the pool above the outcrop the width is about 1 mile, while below the width is 1/2 mile. Hence the 27-ft. difference in elevation between the two pools is reduced when the river rises. When a 16-ft. stage is reached the difference is only 2 ft., the rapidity of the rise in the lower pool being about twice that in the upper pool. Navigation by the river channel is possible downstream when the fall is 7 ft. and upstream when it is 5 ft., but this period is less than two months long and the passage is difficult and dangerous, due to the rapid current, bridge piers and sharp curves. The canal will, therefore, be used practically the entire season. A decision to raise the dam height in the upper pool by 6 ft. made necessary an increase in the height of the lock walls to 53 ft., but this increase permits the abandonment of Dam 40 originally contemplated.

Major J. C. Oakes, Corps of Engineers, U. S. A., presented a full account of the proposed improvement and the early excavation methods in the "Professional Mem-

gates are of the horizontal-arched type backed by heavy diagonal bracing similar to that at Keokuk described in the Engineering Record of July 26, 1913, page 88. The wide upper gates and the guard gates are vertically framed.

Filling and emptying arrangements consist of conduits in the walls with side outlets and inlets above and below the gates respectively.

FILLING AND EMPTYING ARRANGEMENTS

The concrete lock walls rest on the rock above the grade of the bottom wherever the material is suitable, a facing 3 ft. wide being carried down to the lower pool surface and held to the rock face by rods.

On top of these shelves of rock at the ends of the lock on each side are the inlet and outlet conduits, formed of concrete. These mains are valved off with Stoney gates 14 ft. wide and 13 1/4 ft. high, and in addition the rectangular side entrances and exits have emergency 4 x 6 1/4-ft. butterfly gates which were intended to be the main gates until the decision to raise the dam was reached.

of the combination of these reasons the Stoney gates were chosen, the 12.7-ft. circular conduits being changed to 11 1/2 x 12 3/4-ft. rectangles.

GATE DESIGN

The Stoney valves will move in a vertical plane on trains of rollers operating against castings with seals similar to those used in the Panama Canal lock valves, but the operation of the gates is quite different. The stem is connected by three cross arms to two cylinders working over fixed pistons, the latter being secured to the bottom of the well over horizontal I-beams embedded in the concrete. A 1 1/2-in. hole is bored through the center of the plungers for the entrance of oil, which presses against the cap at the top of the cylinders. The pressure is equalized by a cross connection. The cross arms are guided by rollers and slides running in adjustable grooved tracks fastened in the concrete.

To reduce friction trains of rollers are provided connecting with vertical sheaves which are raised and lowered by a cable, the upper end of the cable being fastened

to a shock absorber on the top of the wall, while the other end, after passing through the sheave, is rigidly fastened to the moving valve. Thus the travel of the roller train is one-half that of the valve. Experiments at Panama indicate that the coefficient of friction with a similar arrangement was 0.0226. To this must be added the friction of the valve due to the side water seals—estimated at 1700 lb. From these data it is estimated that a pull of 10,000 lb. is necessary to overcome the rolling friction at the start. The moving parts of the valve weigh 44,000 lb. The oil pipes and apparatus are designed for 1500 lb. per square inch, but 500 lb. will exert a lifting power of 66,000 lb., leaving a margin of 1000 lb. to overcome sticking of the valve and inertia of the starting movement. About 95 gal. of oil will open the gate for inspection the full stroke, 16½ ft. The time is estimated at one minute.

The lower gate is larger than any gate in use except those at Panama and Keokuk. It is within a few inches of being the same height as the Keokuk gate, 48 ft., and differs from it in the following respects: It has no buoyancy chamber and will be operated by a hydraulic jack instead of a bull wheel, and the miter forcing machine, consisting of a jaw on one leaf which seizes a post on the other leaf, will be operated by a hydraulic instead of a pneumatic jack.

SAFETY ARMS ON MITER POSTS

Two sets of projecting cast-steel arms will be attached to the miter post of each leaf to prevent accidents in case of impact by moving boats. Most accidents to lock gates are caused by boats hitting one leaf from below, and pushing the leaf upstream enough to remove the support for the other half, thereby allowing the other leaf to swing downstream and tear loose from its anchorage. If the blow has not force enough to push one leaf entirely beyond the end of the arms on the opposing leaf, the water pressure will bring the two leaves together again.

Owing to silt and the difficulty of cleaning out the recesses at other Ohio River locks where rolling gates are used, this type was rejected for the upper gate. Other peculiar conditions also prevented the adoption of the vertical-lift or movable-dam type. The mitering gate was finally con-

sidered best for the site, although no gate of this type has been built where there was such a small ratio of height to length, 24 ft. 8 in. to 63 ft. The nearest approach is a Sault Ste. Marie guard gate, 27 ft. to 56½ ft. To permit stiffening against warping and sagging the more readily by adjustable diagonals, the gate is of the vertically framed type instead of the ordinary horizontally framed type. As designed it is in effect two Pratt trusses separated 6 ft. by vertical girders, the whole being hung from one end as a cantilever. The skin is between the trusses and near the downstream side of the gate.

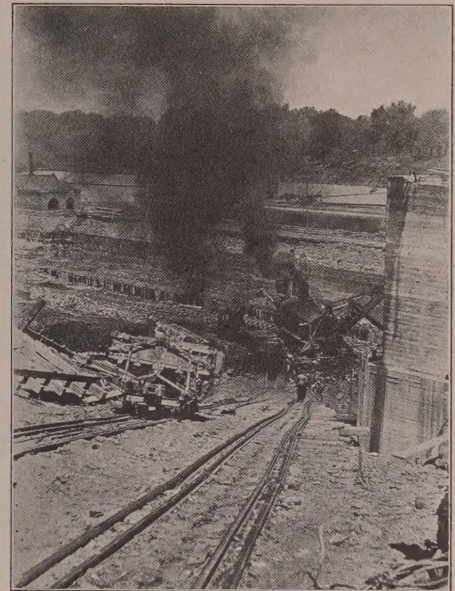
EXCAVATION REMOVED BY AN INCLINE

Excavation of the 44-ft. depth of earth over the site and the blasted 10½ ft. of rock was carried out in the dry by means of a Bucyrus steam shovel and Brownhoist locomotive cranes operating clamshell buckets by which 4-yd. Western dump cars were loaded. Until the pit got too deep and the grade more than 6 per cent, the trains were hauled out by locomotives.

All of the rock and part of the earth was drawn in cars, one at a time, up an incline by a cable-operated dolly running on a narrow-gage track laid between the rails of the dump-car track. At the foot of the incline the dolly track was depressed so that the loaded cars could be pulled or pushed over the depression. Subsequent pulling on the dolly cable brought the latter out of the depression and made it engage the bumper on the dump car. To lower the car into the pit the reverse operation took place. With two tracks in operation one car could be handled every minute, a rate which exceeded the capacity to get the cars to and from the ends of the incline.

HIGH WALL FORMS

Form supports for the high walls, which have only recently been started, consist of mounted structural-steel frames set on tracks on the inside of the lock. They were designed by the Blaw Steel Construction Company and are made up of three 10-ft. bents, similar in construction to those used at Sault Ste. Marie, described in the Engineering Record of Dec. 21, 1912, page 684. Steel form sheets are held in place by the struts which separate the frame from the wall. To prevent uplift an anchor is sunk



HAULING SPOIL UP DOUBLE-TRACK INCLINE

The inside rails are for the dolly.

6 ft. into the rock at every bent and secured to the inner end of the frame. Sliding is also provided for by attaching a cable to the top of the anchor and securing the other end to the outer portion of the frame. Turnbuckles in these connections and in the struts holding the steel forms in place provide adjustment. The back forms are of wood held by bolts to the front face.

To prevent overturning due to wind pressure, 25 cu. yd. of sand and gravel are loaded into a box resting on the lower chord near the outer end.

The framework is moved ahead by means of block and fall, attachment being made to anchors and motive power furnished by locomotive cranes.

ZIGZAG CHUTES INSIDE THE FORMS

The two walls above the upper gates are constructed simultaneously, both being served by a locomotive crane operating over a transverse track between the two forms. Originally it was intended to provide hoppers on the framework discharging through spouts running through holes left in the forms. These hoppers and chutes were finally abandoned and the plan now is to raise the concrete in 1¼-yd. controllable bottom-dump Steubner buckets by the crane over the top of the forms and discharge it into a hopper which will feed it out as desired to a zigzag chute to the bottom of the forms. Sections of these inclined chutes are removed as the concrete rises.

In one of the blocks shown in the photograph there are 1500 cu. yd. of concrete, and it was poured at the rate of 40 cu. yd. per hour, but during an 8-hour day only. In the main wall cross-section 1 lin. ft. represents 25 cu. yd. of concrete. The forms are designed to withstand a maximum rate of rise of the concrete of 1 ft. per hour, kept up continuously. Owing to interruptions due to irregularities in the walls, and the placing of inserts of steel, this rate has not been attained.

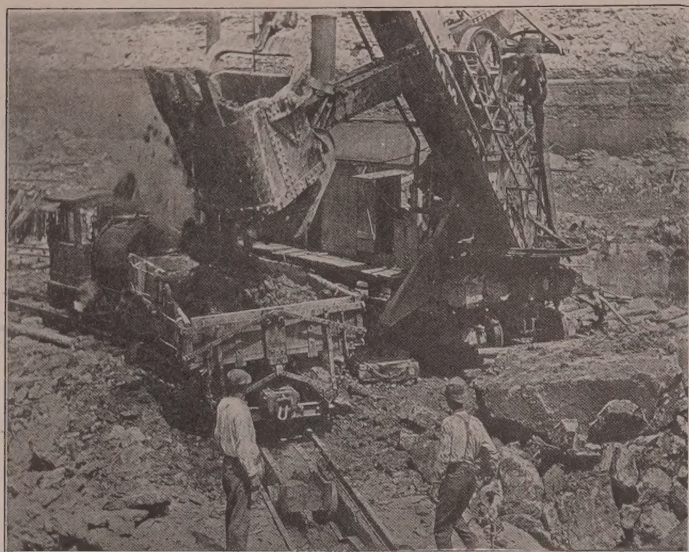
SELF-MEASURING CHARGING CAR

The drawings on the next page show the concrete plant layout. The novel feature is the self-measuring aggregate charging car on which are mounted two steel measures, drawn in at the top to fit the slide gate openings in the roof of the tunnel under the

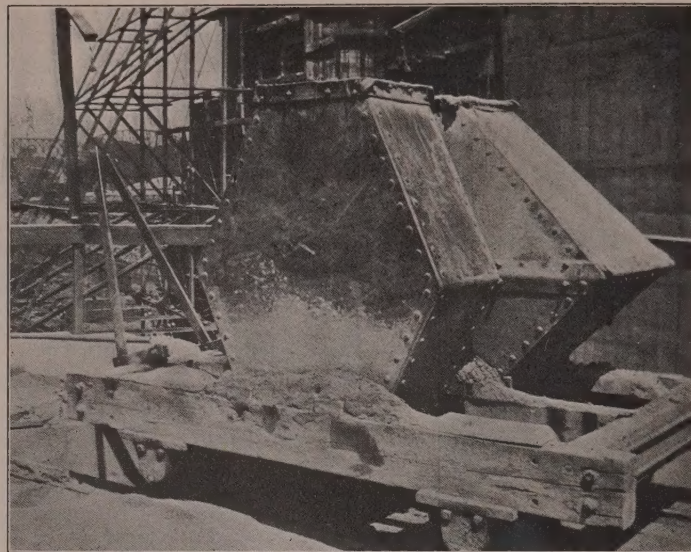


THE GRAVITY FED MIXER DISCHARGES INTO BUCKETS WHICH ARE RAISED TO THE TOP OF THE WALL BY THE CRANE

Note the high structural-steel mounted wall forms.



ABOUT TO HAUL A LOAD OF SPOIL UP THE INCLINE—DOLLY IN PIT IN FOREGROUND



SELF-MEASURING CHARGING CAR TAKES 24 CUBIC FEET OF GRAVEL AND 11 OF SAND

sand and gravel piles. As used at first the clearance between gate and top of car was made $\frac{1}{2}$ in., but trouble with stones wedging led to increasing the clearance to $1\frac{1}{2}$ in. Then to prevent undue spilling the opening in the car hopper was provided with stiff rubber belting. With this arrangement forty batches per hour may be turned out by the 1-yd. Cube mixer, although the rate has been increased to fifty-five batches per hour for short periods.

CRANE TO HANDLE BUCKETS

To handle the buckets to the top of the forms the 50-ft. boom furnished on the locomotive crane was lengthened in the contractor's shop to 70 ft. Movement of the short transverse track on which the crane operates forward to the next position cannot be done until one of the forms has been moved ahead. Then the tracks will be thrown over a little at a time.

The method here described of having the locomotive crane on a transverse track is used only on the short pieces of wall, 200 ft. in length, above the upper gate, where there was not sufficient room to operate two cranes.

In continuing the walls below the upper gate, only one wall will be built at a time, using three 30-ft. sections of steel forms, and two locomotive cranes with the crane tracks immediately back of the forms and running parallel with the wall. The concrete delivery track will be laid immediately back of the crane track. One crane at a time will be used for placing concrete, the other crane being employed building forms and placing iron.

Near the top of the rock surface is an extremely hard, tough ledge, resembling flint, about 6 in. thick. The remaining rock is of hard limestone. At the beginning 4-in. Star drills were tried, but were found to penetrate but 4 in. per hour under the standard blows of the $4\frac{1}{4}$ -in. Ingersoll-Rand wagon drill machines.

SPECIAL DRILL STEEL FOR HARD ROCK

Blows on the rock from an ordinary piece of steel leave a black mark like a lead pencil. The drills were battered up as lead would be. After some experimenting Black Diamond steel hardened to the limit was obtained for the tools and a standard oil well tool with a fluted chisel point adopted. The cutting edge is 4 in. long, sharpened to a 90-deg. angle. With one of these tools a depth of 10 ft. only can be drilled. An average 8-hour day's work in the hard limestone for the two wagon drills is 280 ft. of hole. Due to the fact that the strike of a layer of slate near the top of the ledge makes a sharp angle with the channeled side walls, the channeler has to be restarted frequently and the resulting wall presents a slightly wavy line. When the one Sullivan and three Ingersoll channelers were at work a total area of 50 sq. ft. per day was cut in the hard limestone and 150 ft. in the shale. The same kind of steel as for the drills was used.

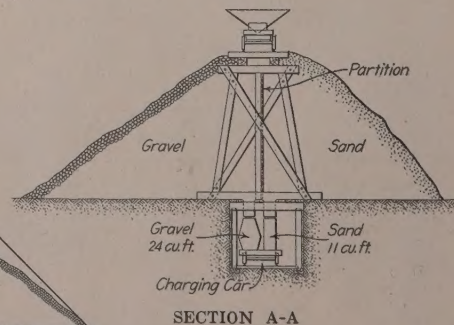
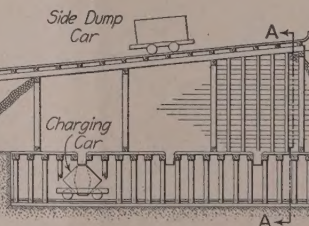
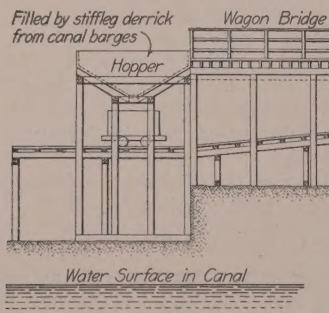
Holes were drilled from 12 to 18 in. below the required grade and spaced 6 ft. apart both ways. For shooting $\frac{1}{2}$ lb. of 60-per cent powder per cubic yard was required. On account of the shock and possibility of damage to the existing canal walls it was

necessary to shoot as few holes as possible at one time. It was usual, therefore, to shoot only eight holes at a time, the charges being set off by wiring laid in the usual way.

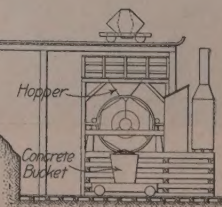
The total amount of rock excavation for the lock pit and contiguous work is 293,000 cu. yd., the ordinary excavation is 876,000 cu. yd., the channeling is 101,300 sq. ft. and the concrete will total 80,000 cu. yd.

The work at the lock is being carried out under the district officer, Major J. C. Oakes, Corps of Engineers, U. S. A. The Ohio River Contract Company is doing the work, with C. H. Wright superintendent. W. H. McAlpine, assistant engineer, has had general charge of the whole improvement, and Malcolm Elliott, junior engineer, has immediate charge of the dock construction.

BACTERIA IN THE LOUISVILLE WATER during 1914, according to the latest annual report of James B. Wilson, chief engineer and superintendent, averaged 9527 in the river and 128 in the filtered water. B. coli were present in 1762 out of 2190 river samples and in 26 out of 2195 samples of filtered water. The removal by the reservoir was 55.7 per cent, by the coagulating basin it was 36 per cent and by the filters 7 per cent. Corresponding removal figures for the suspended matter were 50, 42 and 8 per cent.



SECTION A-A



THE SELF-MEASURING CHARGING CAR IS THE NOVEL FEATURE OF THE CONCRETE PLANT

Railroad Built Around Burning Tunnel in Three Weeks

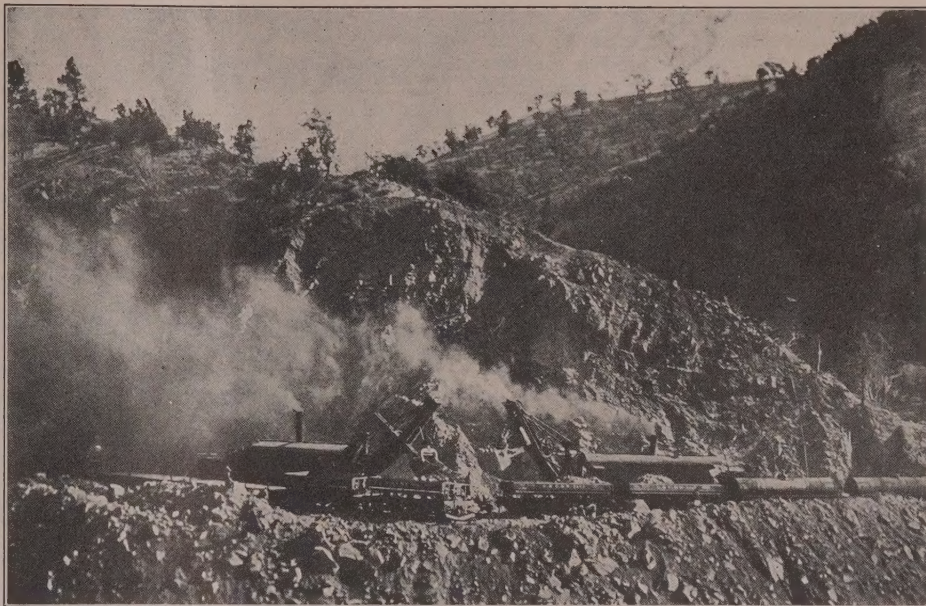
Record Speed in Constructing Shoofly Trestle and Cut to Reopen Main Line of Southern Pacific in California

A TUNNEL FIRE that closed the main line of the Southern Pacific railroad occurred in tunnel 15, near Tehachapi, Cal., on May 14, as noted in the Engineering Record of June 5, page 727. After the timbering had burned, the tunnel, which was 360 ft. long, caved in at both ends, and it was found that the cave-in extended all the way to the top of the hill, 110 ft. over the tunnel, where a depression 100 ft. across had developed after the collapse of the tunnel arch. It was estimated that six weeks would have been the minimum time required to re-open the tunnel to traffic, and twenty-one days for the construction of the shoofly. As time rather than cost was the governing factor, it was decided to re-open the line by building around the tunnel a 1200-ft. shoofly involving a heavy cut and a trestle. This was done under unusually urgent conditions and the work was carried on with the utmost dispatch.

420-FOOT TRESTLE

The timbers and other materials required for a 420-ft. trestle on the shoofly had to be brought from Oakland, 356 miles away. However, twenty-two hours after the order was given this material was delivered at the site, together with the equipment necessary for erection. Extra pile drivers and steam shovels were sent, as well as duplicates in all other equipment used, so that breakdowns need not occasion delay. Another notable feature of the work was that in spite of the haste, safety-first principles were enforced from the outset, and the trestle was completed without a single serious accident. This was accomplished by making discharge the penalty for the slightest laxity in observance of the safety rules.

The trestle had a maximum height of 90 ft. and timber totaling 200,000 ft. b. m. was used in its construction. Of its total length 200 ft. was on pile bents, while for the remaining 220 ft. standard frame bents were used. Eight gangs of carpenters of from 20 to 25 men each were used on the work in two 12-hour shifts. The trestle



TWO STEAM SHOVELS NEARING COMPLETION OF WORK ON CUT

was completed and put in service 8½ days after the material was delivered at the site. The first use of the trestle was the moving across it of the steam shovel. With boom and bucket attached, this shovel carried a load of 65 tons on the front axle.

STEAM SHOVEL WORK

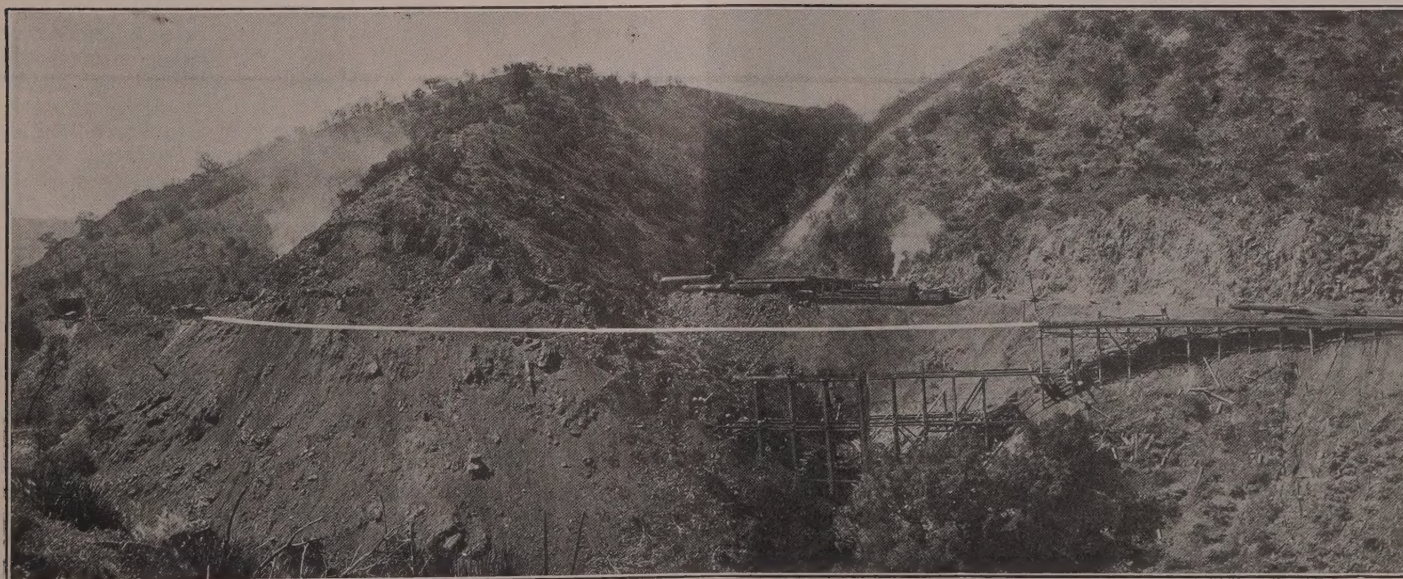
The cut could be attacked by steam shovel only on the south side until the trestle afforded access from the north, so the work was advanced part of the time by one, and later by two 5-yd. Bucyrus shovels. The material moved was granite, and totaled about 36,000 cu. yd. The cut was 64 ft. deep at the center and 105 ft. on the uphill slope line. About 125 drillers and powder men were continually employed on this part of the work, day shift as well as night shift. Ordinarily a through cut would have been made at this point, but it was considered possible to handle the material quicker on a bench or "daylight" cut, and this type was therefore decided upon. The shoofly was completed and opened to traffic June 8, 20 days after the idea of re-opening the tunnel was abandoned.

The rush construction of the shoofly was

carried out entirely by the Southern Pacific Company's own forces, under J. Q. Barlow, assistant chief engineer, and H. B. Titcomb, his assistant. The general scheme of organization, however, being to work through the division forces, J. M. Worthington, superintendent of San Joaquin division, and W. M. Jackle, division engineer, were continuously on the ground from the morning of the fire until traffic was resumed.

Lime Concrete Extensively Used in India and Burma

LIME concrete in the East was described by E. A. W. Phillips in a paper read before the Concrete Institute, London, on May 20. Stone lime of great purity, and consequently non-hydraulic, is used largely in India and Burma, and engineers place considerable confidence in the material. To enable it to set under water "soorkhee," or finely powdered red brick, is mixed with it, usually in the proportion of one part of half-and-half well-burnt and under-burnt "soorkhee," one part of slaked lime and one part of clean sharp sand, all measured in



TEMPORARY GRADE AROUND NOSE OF HILL, INDICATED BY HEAVY WHITE LINE—TUNNEL STILL SMOKING

bulk, dry. The materials are thoroughly mixed and ground in a mortar mill, either under one wheel pulled round a circular track by a bullock, or in a pan machine under a pair of wheels. The mortar made in this way sets very well in still water, but comparatively slowly, and some engineers add, when necessary, a proportion of Portland cement to the mixture. This markedly hastens the setting. One part cement to one part lime by volume apparently sets as quickly as cement mortar. It has been asserted that first-class soorkhee mortar several centuries old exceeds 1:3 Portland cement mortar in strength and impermeability, and it is of course much cheaper. The paper contains results of experiments as to the effect of adding lime to Portland cement in making mortars and concretes on time of setting, impermeability and strength.

Concrete Arch Forms Fall as Steel Trusses Collapse

Failure of Tension Cables on Trussed Forms Wrecks
133-Foot Span of Detroit-Superior Bridge
in Cleveland

DURING the erection of forms for the last long-span concrete arch, on the new Detroit-Superior high level bridge in Cleveland, the steel centering for the south ring gave way about 10 a. m., June 17, carrying with it thirteen carpenters and two structural steel men who were on the span at the time. The steel centers were complete and the carpenter had the forms well under way.

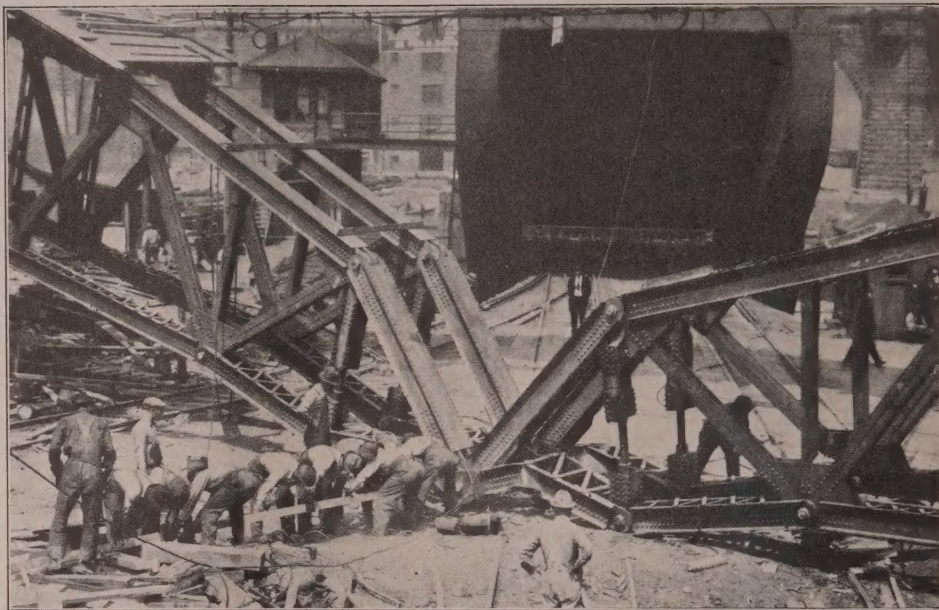
This particular span was over the Baltimore & Ohio tracks, and the steel centers consisted of three-hinged arches of about 133 ft. span, center to center of end pins, and 36 ft. 6 in. rise from the center of the lower pins to the upper hinge. The intrados of the arch is about 60 ft. above the railroad tracks.

CABLES PARTED OR SLIPPED

Each center consisted of two trusses braced laterally and the lower tension members were formed by three 1-in. steel cables

for each truss. The direct cause of the accident was either the parting of one of these cables or the slipping of the clips which were used to tie the loops at the end of the cables.

The reinforced-concrete piers, which were completed at an earlier date, were not injured in the least. The lower chords were buckled in several places, this being clearly shown in the photographs. It will, however, be a comparatively easy matter to repair the trusses. The Hunkin-Conkey Con-



FALL OF TRUSS AT CLEVELAND BUCKLED THE LOWER CHORDS IN SEVERAL PLACES

struction Company were the contractors for the concrete superstructure of the Detroit-Superior Bridge.

THE AVERAGE COST PER MILE of all roads constructed in Louisiana under the supervision of the new highway department is \$965.40. This includes earth, gravel and sand-clay roads.

Road Engineer Experiments with Hydrated Lime

Nathan C. Johnson's Series of Concrete Articles in This Journal Led George A. Quinlan to Attempt to Improve Cement Efficiency in Road Work

PRACTICAL experiments with hydrated lime on a stretch of Illinois concrete road work in which joints are eliminated except at the end of a day's work (350

ft.), are being carried on by George A. Quinlan, superintendent of highways of Cook County, Illinois. Mr. Quinlan's determination to experiment with hydrated lime was influenced by the recent articles published in the Engineering Record on the application of the microscope to the study of concrete, by Nathan C. Johnson, in which it is shown that the cement matrix is not worked at its maximum efficiency, largely because of air and water voids in the mass and that only a small percentage of the cement is hydrated, so that it can perform an active function, the remainder lying inert.

OBJECT OF TESTS

Various experiments with hydrated lime carried on by H. G. Shirley, in Maryland, and R. Edwards, of Portland, Ore., added further to Mr. Quinlan's desire to ascertain whether or not the use of lime in concrete road construction would render the concrete more plastic, homogeneous and dense, and if so whether the results give any practical advantage to offset the increased cost. When concrete is poured there is a loss of water through seepage in the sub-base, evaporation and leakage through the side forms. The lime, it is claimed, undergoes no chemical change, is finer than cement, thus filling in between cement particles and making concrete more dense, and when added to the mix it holds about 20 per cent of its own weight of water which gives an excess of moisture in the concrete while setting, thus producing highly plastic, dense, homogeneous concrete.

Following experiments already carried out Mr. Quinlan has used two methods of proportioning the hydrated lime to the



FORMS FOR DETROIT-SUPERIOR BRIDGE SUPPORTED BY TRUSS PRIOR TO COLLAPSE

mix. In the first, hydrated lime to the extent of 10 per cent of the cement is added to the mix. In the second, 10 per cent of the cement is replaced with the hydrated lime. A 1:2:3½ mix is used.

Mr. Quinlan states that in his experience with placing joints every 100 ft. that he obtained no more cracks than when he spaced his joints 30 and 50 ft. apart. Why put in cracks by design that you are trying to eliminate by accident? is Mr. Quinlan's philosophy. He also figures that maintenance cost is reduced and there are less uneven spots in the road.

EXPERIMENTAL STRETCH NEAR GLENCOE

The tests are being carried out in connection with the construction of 3900 ft. of Green Bay road which is being surfaced by the township of New Trier from the village of Glencoe to the county line. The road adheres to the State specifications which call for an 18-ft. width of concrete 6 in. thick at the side and 8 in. at the center, with 6-ft. earth shoulders. Instead of spacing the joints 50 ft. apart, he has placed them only at the end of a day's run,

New Ohio River Bridge to Contain Longest Riveted-Truss Spans in America

Chesapeake & Ohio Northern Structure at Sciotoville Includes Two Continuous 775-Foot Spans with Many Distinctive Design Features

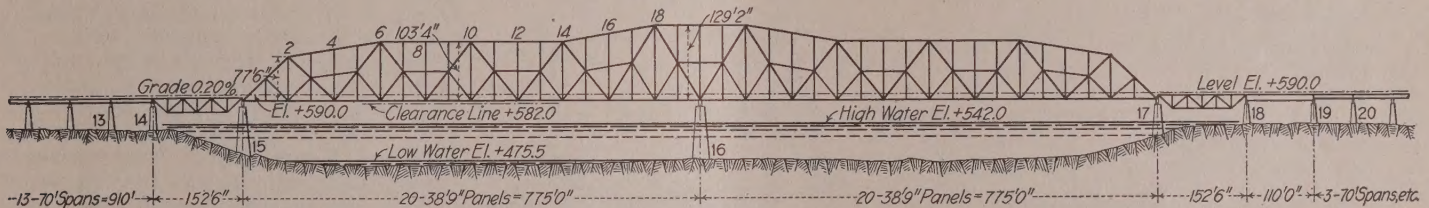
THE MAIN SPANS of the Sciotoville Bridge of the Chesapeake & Ohio Northern Railway over the Ohio River are distinctive not alone in their length, but also in type of construction and many unusual details. Continuous riveted-steel trusses 1500 ft. long, supported on concrete piers 775 ft. apart, are in themselves a striking solution of the problem here presented. At the bridge site the river makes a sharp curve, with its channel near the inner or Kentucky side. At high water river traffic shifts over to the Ohio side. These circumstances made it desirable to furnish two large clear spans, which were fixed by the U. S. War Department at 750 ft. Not alone are these trusses the longest and heaviest of the fully riveted type ever built in America, but the continuous U-frame floorbeams,

pearance as shown by the accompanying elevation. The principal dimensions are there given, and it is seen that a curved-chord subdivided panel type of truss was adopted. It may be noted that the panel length equals the width between trusses.

The concrete piers rest on solid rock, which, in the middle of the river, was found at an elevation of about 10 ft. below the low-water level and extending nearly horizontally across the river. Settlements are therefore not to be expected and do not form the objection which is commonly advanced against this type of continuous-truss design.

LOADS AND ALLOWABLE STRESSES

The design and details were worked out with a view of obtaining a strong and rigid



GENERAL ELEVATION OF 1500-FOOT RIVETED TRUSSES TO BE ERECTED OVER THE OHIO RIVER AT SCIOTOVILLE

about 350 ft. Here a Baker armored joint is placed at right angles to the road.

The first four 350-ft. slabs were laid alternating without hydrated lime and with a lime addition of 10 per cent of the cement. Then two alternate 350-ft. slabs were placed, the first without any lime and the second with 10 per cent of hydrated lime replacing its equal volume of cement. The remaining 1800 ft. of pavement are being placed without any lime additions to the mix.

ROAD LAID UNDER FAVORABLE CONDITIONS

The road is laid under exceptionally favorable conditions as it is practically all in cut and there are no sloughs, heavy embankments, or standing water in the ditches. The road is in level country and has a maximum grade of 1.73 per cent, and that only for a stretch of 300 ft.

Careful records of the temperature, humidity and other weather conditions have been kept each day since the concrete was laid. As the work progresses a traffic census will be taken. Mr. Quinlan hopes to be able to give a detailed report next winter of how the road has stood up after a year's service.

STARCH-FACTORY WASTE AT DECATUR, ILL., averages 4581 parts per million total solids, of which 511 parts are in suspension, according to a recent report to the city by Pearse and Greeley. The volume of waste per day was 750,000 gal. when grinding about 15,000 bu. of corn. Only 200 bacteria per cubic centimeter, mostly of the spore-forming subtilis group, were found, as the temperature of the liquid was 110 deg. Fahr. The biological oxygen consumed showed an oxygen demand of 780 parts per million, 4.7 times the demand for local domestic sewage.

the horizontal traction trusses provided at each panel in the plane of the bottom lateral bracing and the deep lattice girders and curved knee-brackets used for transverse bracing instead of diagonal swaybracing, all form distinctive features of unusual character.

The Chesapeake & Ohio Northern Railway is a new line of the Chesapeake & Ohio Railway, to be built to connect the main line of the latter on the Kentucky side of the Ohio River with the Hocking Valley Railroad at Columbus, Ohio, crossing the Ohio River about 120 miles above Cincinnati. The new line is projected for heavy freight traffic, principally coal trains, for which reason the grade northbound has been limited to 0.2 per cent compensated on curves.

GENERAL DIMENSIONS OF BRIDGE

The bridge across the Ohio River is 1550 ft. long and is approached by viaducts 823 ft. and 1063 ft. long on the Ohio and Kentucky sides respectively, the Kentucky viaduct being built on a 1¼-deg. curve, the Ohio viaduct on a tangent. The total length of the bridge and viaduct approaches is 3436 ft. The approach viaduct consists of plate-girder spans from 67½ to 110 ft. long and two 152½-ft. deck truss spans, all of which rest on solid concrete piers and abutments. The steelwork on these approaches is being built for single track only, but the masonry provides for the future addition of a second track.

The river crossing, which is being built as a double-track span at the present time is a two-span continuous truss bridge 1550 ft. long. A comparison between various designs consisting of successive simple spans, cantilever trusses and continuous trusses showed a decisive economy for the adopted design, not to mention its symmetrical ap-

pearance as shown by the demands of the heaviest immediate and future traffic. The live load is Cooper's E-60 on each track, with allowances for impact according to Lindenthal's formula,

$$I = \frac{L^2}{D + L} \times \frac{1200 + a/n}{600 + 4a}$$

in which a is length of train behind tender and n is number of tracks loaded. The unit stresses used are 20,000 on net sections of tension members and 20,000 reduced according to length ratio by a special table on net section of compression members.

The approximate weight of steel is 13,500 tons. The dead load is 18,800 lb. per linear foot of bridge. The material is open-hearth structural steel of from 62,000 to 70,000 lb. per square inch ultimate strength. As alloy steel at present prices showed no economy over the carbon structural steel, carbon steel was used throughout.

HEAVIEST MEMBERS AND GUSSET PLATES

The heaviest chord member is 4 x 4½ x 77½ ft. long, with a sectional area of 596 sq. in. and a weight of 228,000 lb. The heaviest web member is 4 x 4½ x 75 ft. long, with a sectional area of 511 sq. in. and a weight of 166,000 lb. Some of the gusset plates are the largest ever used and reach the limit of the capacity of the rolling mills, being the maximum size obtainable. For example, gusset plates 130 x 1½ in. x 15 ft. 6 in. long, and 138 x 13/16 in. x 17 ft. 6 in. long are required. The heaviest casting weighs 45,000 lb. and the largest rivets are 1¼ in. in diameter and of 7⅞-in. grip.

The dead load weights were carefully estimated and panel-point concentrations determined for a check on the preliminary dead load stresses. Final stresses based on the actual sections of the members were computed by the elastic theory. Each center

bearing carries a dead load of nearly 5000 tons and a live load of 3000 tons.

RIVETED TYPE ADOPTED

Most chord and web members being subjected to both tension and compression, it was decided to use stiff members throughout. It was found from estimates that no saving could be effected by the use of eye-bars for the few members taking tension only. Pin connections being considered undesirable for members subjected to reversal of stress, it was decided to use riveted connections throughout and thereby secure the greatest possible rigidity. All joints of members, whether in tension or compression, are fully spliced.

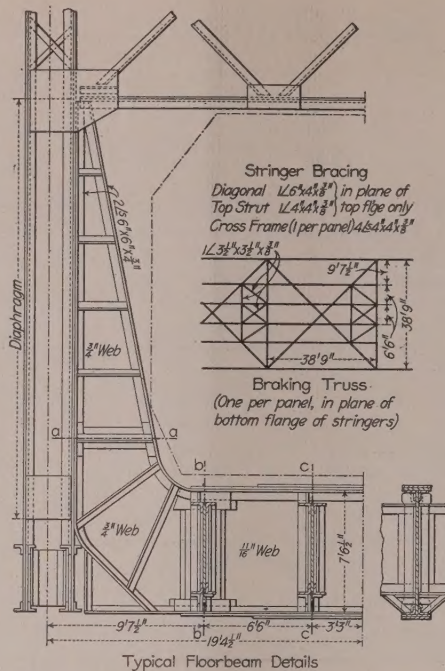
The 775-ft. span on the Ohio side will be erected first, by the use of falsework. Then the trusses will be cantilevered out on the Kentucky side for twelve panels to meet the eight panels there erected on falsework near the shore. The required opening of 350 ft. is thus maintained in the channel for river traffic. Interesting problems in deflection computation, falsework design and erection-stress analysis are therefore presented.

UNUSUAL DESIGN FEATURES

The accompanying cross-sections and details illustrate some of the unusual features adopted in the design of the structure. They were selected mainly with a view of obtaining increased rigidity of the bridge. The floorbeams consist of a continuous U-frame, the vertical parts of which extend up to the bottom of the swaybracing, as shown in the detailed drawing. Exact computation for bending moments at the sections AA, BB and CC were made by the elastic theory. On account of the shallow depth available, ordinary floorbeams would not have been as rigid and would have weighed considerably more.

No expansion joints are provided in the floor system, and a traction truss is provided in each panel in the plane of the bottom lateral bracing to transmit the longitudinal forces from tractive force and braking of trains directly to the trusses without bending the floorbeams. These trusses are indicated on the plan view shown herewith.

Solid plate-girder portals are provided in the planes of the inclined posts over the end and middle piers, as suggested in outline by the views herewith. Deep lattice girders and curved knee-brackets are used for transverse bracing instead of the diagonal



NEW U-FRAME TYPE OF FLOORBEAM—
BRAKING TRUSS AT EACH PANEL

swaybracing ordinarily employed, the type and sections used being shown on the drawing.

The bridge is being built by the Chesapeake & Ohio Northern Railway, of which G. W. Stevens is president, and M. J. Caples, vice-president. The design and detail plans of the bridge and approaches have been worked out by Gustav Lindenthal, consulting engineer, New York City, who is also in charge of the execution of the work. O. H. Ammann, principal assistant engineer, furnished the data here given. The contract for the foundations and masonry has been let to the Dravo Contracting Company, of Pittsburgh, and for the steel superstructure to the McClintic-Marshall Company, of the same city. Construction on the foundations was started in November, 1914, and it is expected that the bridge will be complete and ready for traffic about November, 1916.

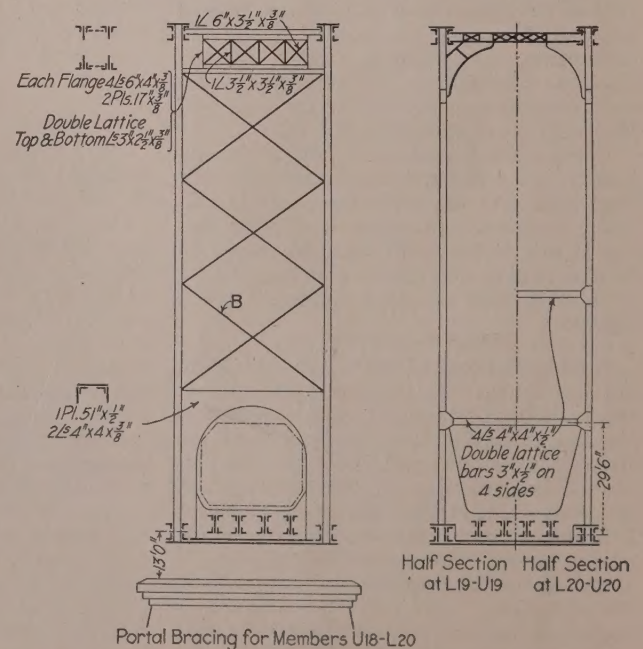
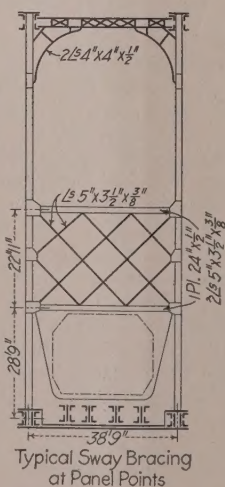
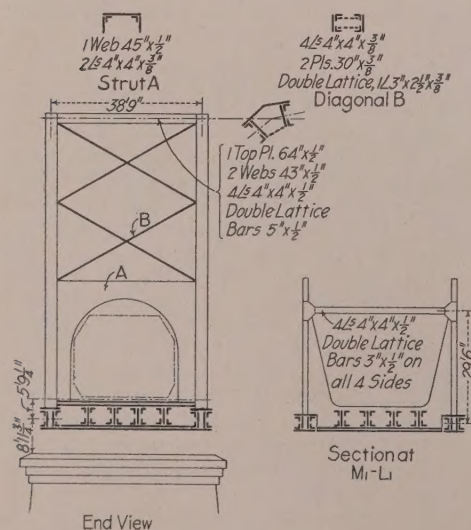
Cut Channel in Ice to Prevent Thrust on Dam

PRECAUTIONS taken by R. A. Cairns, city engineer of Waterbury, Conn., to prevent ice thrust on the Morris dam of the municipal waterworks system, consists in cutting a channel in the ice along the entire length of the structure. An unusually protracted period of low temperature occurred in February, according to Mr. Cairn's report for 1914, producing solid ice to a thickness of 19 in. To protect the weir wall, the upper part of which was only a few months old, from ice thrust, a trench 2 ft. wide was cut about 5 ft. in front of and the entire length of the weir. This was kept open until enough snow fell to cover the ice, after which little movement of the ice took place.

On Feb. 13 a notable movement was observed, the ice floe pushing up the slope of the dam to a surprising extent as a result of the temperature rising from 12 deg. below to 22 deg. above zero in a few hours.

As a result of observations made at Wigwam and Morris reservoirs it would appear to be prudent, Mr. Cairns says, to cut a trench in front of masonry dams whenever heavy ice has formed without a covering of snow to protect it from the bright sunlight. Under such conditions the ice expands in the daytime, with higher temperature. Contracting at night, instead of returning to the original position it forms shrinkage cracks which immediately fill with water and freeze solid, thus increasing the dimensions of the ice field. This action continuing from day to day has been known to push the ice as much as 2 ft. up the slopes of the dams and the shores of the reservoir. Whether the force developed is or is not sufficient to affect the masonry walls of the dams is not easy to determine and it seems best to adopt the inexpensive precaution of occasionally cutting a narrow channel through the ice.

STREETS PAVED FOR A CENTRAL GUTTER are being experimented with at Sacramento, Cal. Both sidewalks and street drain toward the center. The city street department believes the new scheme will effect a considerable saving.



INTERMEDIATE SWAYBRACING WITH BRACKETS AND PORTALS WITH SOLID WEBS—DOUBLE DIAGONAL BRACING SYSTEM USED

Quality of Concrete Controlled by Tests of Sand

Third and Final Article of Series Proposes Check on Materials by Means of Portable Device Which Simplifies Usual Analysis Routine and Gives Direct Graphical Records—Existing Test Methods Are Critically Discussed

By CLOYD M. CHAPMAN, Engineer of Tests, Westinghouse Church Kerr & Company, New York,
and NATHAN C. JOHNSON, Consulting Concrete Engineer, New York

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IN THE first article of this series, in the issue of June 12, page 734, sand tests as an important factor in concrete making were considered particularly from the standpoint of the contractor, with a specific example to show some latent and usually neglected possibilities. In the second article, published June 19, page 771, the necessity for tests, both to contractor and owner, was demonstrated by a study of the physical structure of sands, by a consideration of the impurities natural to them and by the effect their physical qualities have on the strength and durability of the concrete. In this, the third and final article of the series, the means at hand for determining the various properties of sands will be discussed, together with the interpretation of results necessary to make the tests of practical use and benefit.

TESTS MUST PRECEDE CONSTRUCTION

Unnecessary as it may seem to bring up such a point, it is desired to emphasize that tests of materials for concrete should be made *before*, not *after* the materials are purchased or the concrete mixed. Ridiculous though this statement sounds, it is by no means an unusual occurrence to have all materials contracted for, the forms up, and the gang ready to begin, if not actually placing concrete, before tests are even given consideration. To have a laboratory make routine or even special tests of a defective sand, cannot cure the ills of concrete already made with it, nor are such tests, unless made for the purpose of analyzing failures, anything but a waste of time, and money. Unless the quality of a sand is well known from thorough examinations previously made, sand tests should rank among the earliest and most-important preliminaries in anticipation of bidding. Even in such cases, because of the variation usually encountered, it is better to confirm earlier results by later examination of the sand actually to be used. Further, it should be borne in mind that thorough sand tests require at least 28 days from the time of receipt of the sample in order that the test pieces may age. It is as foolish to delay or to omit tests, especially of unknown or doubtful sands, as it would be to submit a bid without figuring quantities or without knowing the cost of materials.

DANGER IN INADEQUATE SAMPLES

Since sand tests are necessarily made upon restricted quantities, it seems trite to say that the first consideration in testing sands should be to obtain a representative sample, yet many times a year the laboratory of Westinghouse Church Kerr & Company, and doubtless other laboratories as well, are called upon to pass judgment on a handful, or envelope-full, or a cigar-box full of sand, without an item of information as to the method of taking, or the source of the sample. To send to a laboratory an improperly selected sample is sheer waste of time and money, yet it is

an exceedingly rare occurrence to find that proper and necessary precautions in taking samples have been observed. Testing an inadequate "sample" is less logical, in view of the tons of sand which will be used on the job, than to candle one egg of a crate to determine whether all the eggs are fresh.

Assuming, however, that a representative sample has been obtained, the question of its disposal becomes of importance. In some instances it will be handled in the contractor's own laboratory, but in a majority of cases it will be sent to a commercial laboratory which makes such tests a business. Quite reasonably, most concrete men, unless they have special knowledge of sands, desire their responsibility to end with the collecting and shipment of samples to the laboratory. Unfortunately this is impossible. Responsibility is only beginning when laboratory results are obtained, for there is no magic in tests, such that the mere fact of their having been made will secure the quality of concrete desired.

Test results, properly applied, must govern the field work throughout, from the digging of the sand to and including the placing of the last concrete. Determining the field procedure in this way often requires special knowledge, but in having such a procedure so determined govern the mixing gang the contractor is not cutting his own throat, nor does the engineer belittle himself or disparage his foreman's practical knowledge. On the contrary, both are proving their own understanding of the questions involved and are supplementing the physical and mental equipment already on the job by other equipment which they should not be expected to possess.

Routine tests, as pointed out in the first article of this series may have no meaning to the contractor, but if these same tests are properly interpreted they may show that a blended sand or a washed sand will give better results than any available raw sand, and in all cases will give an indication as to the proportions in which materials should be used. But, knowing these things, it is useless to go on mixing materials in the "good old way" that is so often a "bad old way" and expect at the same time to get the quality of concrete wanted. A saving in cost of materials can only be effected through compliance in field procedure with such recommendations as are indicated from test results. For instance, if some proportions such as 1:1½:6 are indicated by tests, rather than 1:2:4, those proportions should be followed through for every yard of concrete on the job. The best physician in the world cannot aid even the most distinguished patient if the prescriptions given are filed away without being administered.

Sand testing is yet in a stage of development, but standard methods are rapidly being developed through much investigative work, both in this country and abroad. But although different laboratories may not follow the same methods and may not even use the same tests, they arrive at

practically the same conclusions, and the majority of methods in present use are sufficiently good to warrant confidence in their findings. Certain tests, however, are very generally used in most commercial laboratories, the procedure differing only as to details. Some of these tests give direct and conclusive evidence of the quality of the concrete or mortar that the sand will produce. Others give only indirect or relative data.

PARTICULAR PROPERTIES OF FINISHED WORK

It is manifestly of the utmost importance that the tests made shall relate to the particular quality the finished product is required to possess. If the concrete is to go into such structural members of a reinforced-concrete building, as columns, girders, beams and floor slabs, where it will not be exposed to water action, the chief, in fact, the sole requirement is *compressive strength*. If the concrete is for use in a sea-wall, a reservoir, or drain-tile, where *impermeability* is of greatest importance, it should possess this quality in the highest degree, regardless of whether or not the strength is as great as could be secured. Strength and impermeability are the qualities most frequently required, but there are individual cases in which others would be of even greater importance, such as ability to withstand high temperatures, as in fireproofing; or resistance to abrasion, as in road-making or floor surfacing; or resistance to certain chemicals, or oils, as in storage tanks. There is as little need of knowing the fireproof quality of concrete for a water reservoir as there is of ascertaining the permeability of a concrete chimney.

Unfortunately, however, the commonly applied tests do not seem to be directed toward the determination of any qualities other than strength. This is not wholly the fault of the testing laboratory. When a sample of sand is sent to a laboratory for test, the purpose for which the concrete will be used, and the service to which it will be subjected should be particularly stated, in order that the laboratory may choose such tests as will furnish the information desired.

In routine tests it is usual to make several of the following determinations:

1. Tensile tests of mortar made with one portion of cement to three portions of the sample sand, as compared with a like mixture using standard Ottawa sand.
2. Comparative compression tests of like mortars in small prisms or cylinders.
3. Granularimetric, or sieve tests, sometimes called mechanical analysis.
4. Percentage-of-voids test.
5. Silt, clay and loam determinations.
6. Density tests on trial mixtures with varying proportions of cement.
7. Weight per cubic foot of the sample sand.
8. Permeability of mortar and concrete made with the sample sand.

The above tabulation of tests may or may

not be in the order of their importance, according to the use required of the mortar or concrete. To determine the value of each for any specific purpose, the nature of each should be considered.

TENSILE STRENGTH

First.—The tensile test of 1:3 mortar briquettes made with cement of known average quality and the sand submitted, such briquettes being broken at the ages of 3, 7 and 28 days, or at 7 and 28 days, shows how rapidly the sand allows the cement to harden and shows the cohesive effect of the cement with that particular sand. But before an opinion can be formed as to the strength-producing value of the sand, there must be a basis of comparison, and this basis is had from a parallel series of tensile strength tests using standard Ottawa sand and the same cement. There is thus established directly the relative strength-producing qualities of the sand under test when mixed with cement. The chief value of this test lies in the comparative data it gives as to the setting-up, or hardening qualities of the cement-sand combination.

The rate of hardening is also indicated by the relative strength of the short and long period tensile tests. This is particularly true when the 3-day test is made, as well as the 7 and 28-day tests. If the 3-day test shows strength relatively high it would indicate to the contractor that forms might safely be removed from the concrete at a comparatively early period; whereas if this test shows a low strength, although the longer time tests show proper strength, it would serve as a warning that forms should remain in place long enough to permit the development of a safe strength in the structure. But even though the tensile strength as shown by this test may be low it does not necessarily follow that the sand will not produce a suitable concrete for many purposes. Oftentimes the use of proportions other than 1:3 will show that a mortar of proper quality may be produced, even where strength is of prime importance.

COMPRESSIVE STRENGTH

Second.—The compressive-strength test of mortar of one part of cement to three parts of the sample sand, made in the form of small prisms or cylinders broken at the ages of 7 and 28 days, gives much better evidence as to the strength-producing quality of the sand than the tensile test discussed above. Concrete is seldom required to withstand tensile stresses. It is therefore rare that it is necessary or even desirable to know its strength in tension. The relation of the tensile to the compressive strength of mortars is, in general, variable over wide limits, and no definite ratio can be established. It is therefore necessary to use this test in all cases where the compressive strength of the concrete or mortar is of first importance. The use of only one fixed ratio, of one part of cement to three parts of sand in making this test, is to be criticized for the reason that the results do not enable the engineer to determine in what proportion cement will have to be used with the sample-sand to produce a mortar of the desired quality.

This test is sufficient of itself in those cases in which it is desired only to determine which of several sands makes the strongest concrete when used in the usual, everyday proportions. But assuming that

one sand only is available, giving a strength in compression of 2000 lb. per square inch as compared with 3000 lb. per square inch for standard Ottawa sand at the same age; and assuming further that the engineer or contractor desires to make a mortar or concrete having a strength of 3500 lb. per square inch at the same age, how will this test help him? It is probable, as stated above, that by the addition of a definite amount of cement the increased strength may be secured, but the question at once arises, "How much cement?" There is no way except by test to determine this, and as it is a question that arises often, it should be anticipated and forestalled by making compressive-strength tests on mortars containing varying proportions of cement and sand, covering a range that is likely to include the strength desired.

It is highly desirable, therefore, that routine tests of a sand include compression tests of a number of proportions of cement and sand, preferably with the particular quality or brand of cement which will be used on the job. With these data in hand it is easier to determine the amount of cement required in making the mortar or concrete. This test is of primary importance where the first requisite of the finished work is *strength*, but it gives but little aid in those cases where impermeability, fire resistance, resistance to abrasion, or some other quality is more essential.

SIEVE TESTS

Third.—The granulometric or sieve test, made by passing a sample of the sand through a series of successive sizes of wire screens, shows the composition of the sand as to the proportion or number of particles of each size separated. For the reasons explained earlier in these articles it is important that concrete aggregates shall be so graded as to size of particles and the proportion of each that the resulting mixture will pack together closely and so leave a minimum of voids to be filled by the cement. Other conditions being equal, that sand which is so graded that the greatest density of the resulting mixture is secured will make the strongest and densest mortar or concrete.

This test is, therefore, of considerable value as a means of predetermining the comparative density of a mortar. Where there are no alternative factors, such as the presence of deleterious matter, shape, surface condition, chemical composition, physical strength, etc., of grain, it may also be used by one of experience to judge of the quality of the concrete which the sand will make. That is to say, given a clean silicious sand of well-rounded grains of pure, or nearly pure quartz of high strength, the properties of concrete made from such a sand will be governed by its granulometric analysis. But with the other qualities of the sand undetermined the data obtained by this test give no positive information as to the strength of concrete which the sand will produce except in cases of extreme fineness, or coarseness, or uniformity of size of grains.

PERCENTAGE OF VOIDS

Fourth.—The percentage-of-voids test, made by determining the proportion of the total volume of a sample of the sand which is taken up by the air and moisture lying between its grains, gives information only as to the degree with which the fine particles fill the spaces between the coarser

particles. However, this compactness depends upon the method of placing the sample in the container and also upon the amount of moisture present in the sample and constitutes a great weakness of the test.

The greatest difficulty in making this test is that of securing a uniform degree of compactness of the samples in the container in which the volume is measured. With the same sample of sand, by simply varying the method of filling the container, it is possible for different operators to get a variation as great as 25 per cent each way from the average, or a total of 50 per cent in determining the weight of sand in a unit of volume. This means, that determinations of the percentage of voids in a sand may vary as much as 50 per cent. As an illustration from an actual case which occurred in a series of investigations of the subject made by one of the authors, a fine dry silica sand gave results varying from 37 to 48.2 per cent of voids with the same operator. Until a consistent standard method for determining voids has been devised and adopted this test can have no particular value.

There is another shortcoming of this test which is no less important than its present inaccuracy, and that is the fact that even though a consistent and reliable test were standardized the information obtained applies only to the sand when alone, unmixed with cement. What is really wanted is a knowledge of the actual space occupied by the sand in a unit volume of mortar, wherein each sand grain is separated from its neighbor by a layer of cement. In the test as usually performed, however, the particles are in direct contact with each other. It is obvious that these two conditions are essentially different and that while a knowledge of one is useful, the other is of little or no value.

The test, therefore, as at present usually employed in routine testing, is of no particular worth, and leads to erroneous conclusions. If developed so as to give the percentage of space between the sand particles in mortar, including that occupied by air, water and cement, it might become of value in proportioning concrete.

SILT, CLAY AND LOAM

Fifth.—Tests for silt, clay and loam, made by separating out with water the finest particles from a sample of the sand, and determining the percentage of the fines so removed, give valuable data in certain cases. Such a test does not, however, of itself give evidence of the quality of concrete which a sand will produce, unless there has previously been established the safe limit of fine material which the sand may carry. This safe percentage varies greatly in different sands and probably depends largely upon the nature of the particles. Some artificial sands, produced by crushing rock, contain as high as 15 to 18 per cent of fine material, which can be removed by washing, yet these sands may produce most excellent concrete. Other sands, on the contrary, containing less than one-half, or even one-third of this quantity, are greatly improved by washing. The test is therefore useful chiefly as a method of control on sands which contain silt, clay or loam of an objectionable nature.

DENSITY

Sixth.—Density tests on trial mixtures containing varying proportions of cement

are made by determining the actual net volume of cement and sand in a unit volume of a series of mortars in which the cement content is progressively increased. By means of this test the mixture may be found which possesses maximum density, that is, which contains the greatest absolute volume of cement and sand in a unit volume of mortar. Theoretically, such a mixture should produce a concrete of maximum strength as well as minimum permeability. While this test is no doubt valuable as an indicator of the mixture which will produce maximum density it stops short of supplying direct and dependable data on the exact strength or permeability of a mortar or concrete. If, however, the batches of mortar made up for this test were formed into test pieces and broken in compression the results would then be in a form which could be directly utilized.

WEIGHT PER CUBIC FOOT

Seventh.—The weight per cubic foot of a sample of the sand, made by weighing a known volume, either 1 cu. ft. or less, gives the same kind of information, in connection with a knowledge of the specific gravity of the material, as is given by the percentage-of-voids test. That is, it shows a degree to

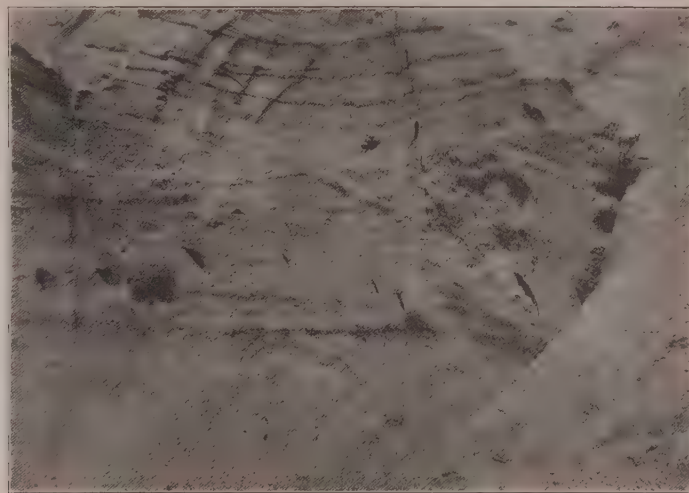
face of a specimen of good concrete takes place as rapidly as the water comes through it. It has been shown that with suitable materials mixtures richer in cement than 1:7 may not allow visible water to pass through six-inch sections even though the amount passing into the specimen is readily measurable.

Many other tests, which space does not permit of discussing in this article, may be applied to routine work, such as microscopic examination, specific gravity, chemical analysis, loss on ignition, etc. Another class of tests rarely used in routine work, comprises those special tests, alluded to before, for determining the resistance of the mortar or concrete, made with the sand sample, to special conditions such as abrasion, heat, oils or chemicals, etc. These tests also fall outside of the scope of this

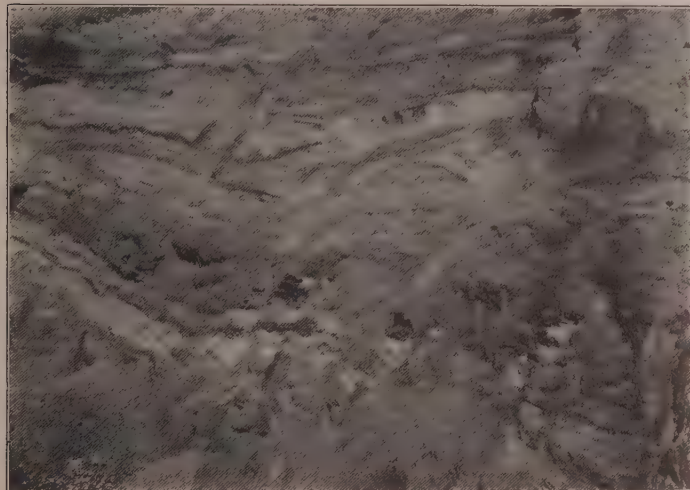
clay to gravel are evident. It follows, therefore, that unless an expensive sizing plant is installed to grade the bank materials, with much attendant waste, the materials supplied to the job must necessarily vary in granularmetric composition. Nor is a supposedly uniform deposit necessarily free from these variations, which must tend to alter the proportions of the materials as used on the job, with correlative variation in the quality of the concrete. For this reason, and also to guard against the accidental introduction of injurious materials during the course of the work, sand tests should continue on all shipments of materials throughout the job. This does not mean, however, that sand may be used only after 14 or 28 days of storage to allow briquettes made from it to age.

Having once determined by suitable tests

AT LEFT—FIG. 11.
—LONG ISLAND
SAND BANK SHOW-
ING ALL VARIATIONS
OF MATERIAL FROM
CLAY TO GRAVEL



AT RIGHT—FIG.
12.—CONDITION OF
NEW JERSEY DE-
POSIT INDICATES
STRATIFIED AND
VARYING CHARAC-
TER OF SAND BED



which the finer particles fill the interstices between the larger pieces and so govern the weight of material which will occupy a unit volume. The value of this test is limited by the same shortcomings as the voids test, which, as mentioned above, are the want of a consistent and standardized method of making and the lack of a useful purpose to which the results may safely be put.

PERMEABILITY

Eighth.—Permeability tests made by subjecting specimens of mortar or concrete to water under pressure and determining the amount of water which passes through or into the specimen, shows the ability of that cement-sandstone combination to exclude water.

Usually this test is performed on a series of varying mixtures, so that the data obtained are indicative of the combination to use to secure the best results. The methods used in making this test may be divided into two classes, one in which the amount of water which passes through the specimen and drips off the outside is collected and measured, and the other in which the amount of water passing into the specimen is measured. The latter class is to be recommended for accurate work for the reason that evaporation from the outer sur-

article but are of great importance in certain cases.

In fact, the subject of tests and their individual value and shortcomings has been so briefly touched upon that many really important points have been entirely omitted to avoid confusion and complication.

QUALITY OF SAND DEPOSITS VARIES

Making due allowance for variations in laboratory procedure, the preliminary tests should yield results which will show how well adapted the submitted materials are to the making of concrete for the particular purpose desired. It is unfortunately true, however, that securing the best results in field work is conditioned on an important qualification—that materials used shall be of like quality with the sample. This uniformity is almost impossible to insure, for sand deposits may vary widely in quality and character, due both to the manner of formation of the sand, and to the manner of its deposition, as outlined in the second article of this series (See Engineering Record, June 19).

This variation in two sand deposits now being worked—one of which is in New Jersey and the other in Long Island, is illustrated in Figs. 11 and 12. In both photographs, all variations of material from

that a sand deposit is free from injurious organic or other deleterious substance, such as mica, etc., and that it is composed of rock particles capable, if properly graded, of producing concrete of the desired quality, either as to strength, permeability, resistance to heat, or abrasion, or to the action of water, or other substances with which it will come into contact in service, it is usually sufficient thereafter, and always of the greatest importance, to know the granularmetric composition of the several shipments. If this granularmetric composition does not vary beyond too wide limits the proportions determined from preliminary tests may be adhered to. If, however, there is wide variance it may be necessary to combine materials or to vary the proportions of the mix in such manner as to allow for these changes in physical composition.

FREQUENT SIEVE ANALYSES NEEDED

It is held, therefore, that after the thorough series of tests made previous to starting the work, the production of concrete of the quality desired is mainly dependent, so far as quantity of materials affects it, upon the maintenance of like granularmetric composition in the sand. This means that aside from the questions of good cement, clean stone of proper grading and quality, clean water, thorough mixing, proper placing and the like, a granularmetric analysis of all sand shipments to the job offers a close control of the quality of concrete to be produced. When it is reflected that concrete is now bought and sold with no guarantee, aside, perhaps, from a surety bond covering a year or two of life for the structure, the importance of insur-

ing quality, rather than paying damages for the lack of it, can be appreciated. Two years of life guaranteed under bond for your tunnel, dam, bridge, dock, or buildings! What a commentary on the haphazard making of an unapproached structural material!

The granulometric analysis most commonly used at the present time is the standard sieve analysis. As before stated, this is performed by passing a sample of the sand through a series of graded sieves having standard-size openings and weighing the material retained on each sieve. From the data thus obtained the percentage of particles of each size is calculated.

To accomplish this analysis, the apparatus shown in Fig. 13, is required. Since sand by definition is such particles of rock material as are below $\frac{1}{4}$ in. in size, it is assumed that all sand tested will pass the $\frac{1}{4}$ -in. sieve. In case there should be doubt on this point only such particles as are found to do so are used for analysis.

It is sufficient for most sand analyses to separate the sample into six sizes. This requires five screens, whose openings may vary in size, according to individual preferences. A representative series is Nos. 100, 60, 30, 16 and 8 mesh. The several percentages passing may then be plotted against sizes of openings (i.e. sizes of particles) on cross-section paper, as was done in the illustrative case in the first article, Fig. 2 (see Engineering Record, June 12, page 735).

NEED FOR FIELD TEST APPARATUS

This procedure is relatively simple in the laboratory, but to follow it through on the job, particularly on all shipments, is more difficult. It is necessary to dry the material, before attempting to pass it through the sieves, because of the tendency of the particles, particularly with fine sands, to pack together and to stick to the finer screens. Since the percentage of particles below 60 mesh is of particular importance in concrete, it is evident that an analysis made without at least air-drying the sample is of little value. This requirement of drying necessarily imposes a certain loss of time which may cause serious inconvenience to the work.

It is also recognized that the proper and conscientious performance of such analyses requires on each job a trained operative, whose salary most organizations would hesitate to add to their overhead expense. Further, it is not only necessary that the tests shall be carefully performed, but also that they shall be capable of ready interpretation and that accurate records of them shall be kept without imposing an undue amount of labor, either on the testing man or the clerical force. There should also be duplicates of such records sufficient in number to permit reference of all results to the main office, both for purposes of record and for decision by higher authorities as to acceptance or rejection, in case materials of doubtful quality are indicated.

The sieving equipment before described does not readily lend itself to the fulfillment of these requirements. It is not readily portable, so that careful samples of each delivery of material must be taken and transported to the apparatus, with loss of time where the job is of large size and points of sand storage scattered. Further, each sample must be dried before sieving, and the percentage retained on the several sieves tabulated on a report sheet, which

often is almost bewildering by its complexity. Further, ready reference to a criterion is absent, unless the tabulated results are plotted in graphical form.

NEW PORTABLE SIEVE DEVICE

With the object of minimizing these several difficulties and of securing additional benefits, the authors have devised a field apparatus illustrated and described in the "News of the Week" section of this issue.

As is shown in this description, the apparatus is intended to offer a rapid and easy means of testing for granulometric composition without the necessity for preliminary drying or any weighing, either of the sample itself or of the various portions into which it is separated in the process of testing. It also provides simple means for showing graphically the results of tests

a positive and constructive nature which will be of direct benefit, rather than to give negative criticisms. To make evident, however, the basis on which these constructive efforts rest it has been necessary to call attention to the shortcomings of routine tests as commonly practised, not with a view to lessening, but rather to increasing their use through promoting an understanding of their values and through stimulating investigation whereby such shortcomings may be removed.

Old Abandoned Polk Street Tunnel, Chicago, Is Bulkheaded

IN CONNECTION with the construction of the new Pennsylvania freight terminals in Chicago over the old Polk Street water tunnel it was decided to bulkhead the tun-

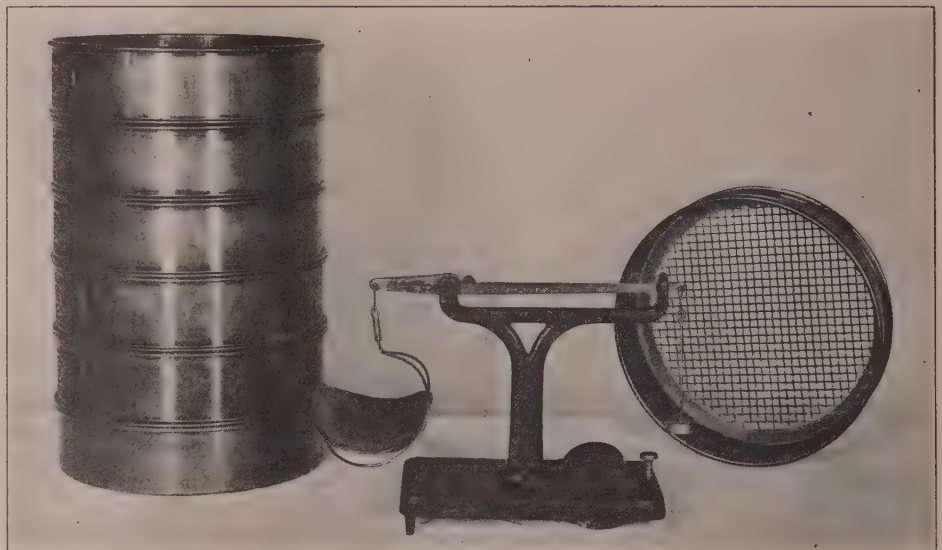


FIG. 13.—EQUIPMENT ORDINARILY USED FOR GRANULARMETRIC SAND ANALYSES

without mathematical calculation or plotting of curves. It may, therefore, be operated by others than specially skilled men.

INTERPRETATION OF RESULTS

As before stated, it is essential that the testing laboratory shall first establish by thorough tests and investigation of their qualities the proportions in which any given materials should be used. This may be accomplished by establishing on cross-section paper limiting maximum and minimum curves between which the curve plotted from the results of the sieve tests shall fall. In the new instrument this end is accomplished by indicating on the printed record sheet the limits within which each grading shall lie. In case the plotted curve of any sample falls outside the established limiting curves or beyond the limits indicated on the record sheet, the seriousness of the variations must be taken into consideration and referred, when necessary, to higher authorities for decision. In this way, an entire job may be kept under close control.

In closing this series it is desired to emphasize that the science of testing sands for concrete is yet in a formative stage. It has been the endeavor of the authors to make plain the necessity for such tests by drawing attention to certain phases of the subject which it is believed have been known to the few rather than to the many who are interested directly or indirectly in the great industry of making concrete. It has also been their endeavor to offer suggestions of

nel at its south end. The photograph on the front cover shows men at work cutting the lining for the bulkhead. The tunnel, which has been abandoned for the past ten years, was built in 1874. It is interesting to note the well preserved condition of the brick work forty years after its construction.

GRADES AND COMPENSATION for engineers in the employ of the city of New York have been suggested by a committee of the Municipal Engineers of New York City. The following schedule for the engineering service, professional class, has been recommended: Grade A, engineering assistant, annual rate of compensation, \$900, \$1020 and \$1140. Grade 2, assistant engineer, annual rate of compensation, \$1260, \$1380, \$1500, \$1620, \$1740, \$1860, \$2040 and \$2220. Grade 3, senior assistant engineer, annual rate of compensation, \$2400, \$2640, \$2880, \$3120, \$3360, \$3600, \$3900. Grade 4, engineer, annual rate of compensation, \$4200, \$4500, \$4860, \$5280, \$5700, \$6120 and up. It is recommended that entrance into grades 1, 2 and 3 shall be by means of open competitive civil service examinations, or by promotion examinations into grades 2 and 3. Entrance into grade 4 shall be by means of a qualifying examination to establish a list from which selection may be made by the appointing officer or by promotion on designation of the appointing officer of a candidate eligible for promotion.

Ashland Water-Rate Decisions Explained

Wisconsin Railroad Commission Declines to Accept 4 Per Cent as Adequate Return for Capital Invested in Public Utilities

By W. E. MILLER

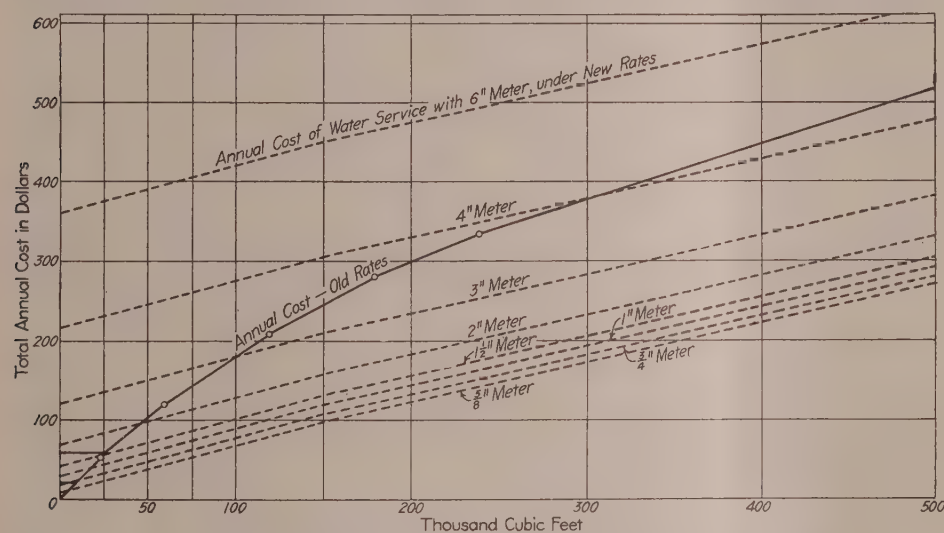
Division Engineer, Railroad Commission of Wisconsin, Madison

TWO IMPORTANT decisions were rendered last year by the Railroad Commission of Wisconsin in connection with water rates at Ashland. In the first, handed down in February, the commission authorized a 25-per cent increase in the water company's gross earnings, most of this to be paid by the city through a higher rate for hydrant service, and ordered a new, more equitable and generally lower schedule of rates for metered service, together with a somewhat higher flat rate for unmetered service. Although the decision was consistent in the main with the valuation of the plant and recommendations of the con-

as between private and public consumers."

As to the matter of rates, the commission held that the gross earnings of the company should be increased from about \$55,000, that being the average for the last two years, to \$68,350. It also held that the amount chargeable to the city for municipal hydrant service alone should be increased from \$15,110 to \$24,300, with an annual charge of 8 cents per foot for any additional mains and \$6.50 each for any additional hydrants.

The metered consumers, of which there were 555 in a total of 1981, had been contributing slightly more than was appor-



COMPARISON BETWEEN OLD AND NEW RATES FOR METERED SERVICE

sulting engineer employed for the purpose by the city, the city petitioned for a rehearing, which was granted. Little new evidence was presented, however, and the decision of July reaffirmed that of February, although compromises in minor particulars were made. Instead of justifying the public criticism of the commission prevalent in Ashland, that the rates were exorbitant, the commission averred that they were really too low, but that adequate returns could not for the present be allowed, on account of the depressed conditions in Ashland. While the city thought 4 per cent ample, the commission deplored the necessity for so low a return as 6 per cent.

SERVICE RATES

The original notice of investigation of the rates, rules, regulations and service of the Ashland Water Company was issued May 8, 1912. In the course of the proceedings a petition and application was filed by the company praying "for such revision and establishment of rates for water service rendered by the company, both for private or domestic consumers and for public or municipal service of all kinds, as shall be found needful and proper, first, to afford a fair return to the company upon its plant and property used in the service, after paying the costs of operation and maintenance and all proper charges and allowances thereon, and, second, to establish rates which are more equitable in their relations

tioned to them from the amount of gross income used as the basis of the new schedule. These consumers had been paying minimum bills of \$1 per month for a $\frac{5}{8}$ -in. meter, \$2 for $\frac{3}{4}$ -in. and 1-in. meters and \$5 for larger sizes. The quantity rates had been as shown in Table 1. The flat-rate consumers had been contributing only about 80 per cent of the amount apportioned to that class of service, and were increased accordingly.

The new schedule for the metered consumers was as shown in Table 2. By it the

TABLE 1—QUANTITY RATES UNDER OLD SCHEDULE

	Cubic feet	Cents per 100 cu. ft.
First	2,000	22.5
Next	3,000	18
Next	5,000	15
Next	5,000	12
Next	5,000	9
Next	30,000	7
Next	100,000	6
All over	150,000	5

TABLE 2—RATES UNDER NEW SCHEDULE

Monthly Service Charges		Monthly charge
Size of meter, inches		
$\frac{5}{8}$		\$0.75
$\frac{3}{4}$		1.50
1		2.50
1 $\frac{1}{2}$		3.50
2		5.50
3		10.00
4		18.00
6		30.00
Output Charges		
For 12,500 cu. ft. or less per month		6 cents per 100 cubic feet
For greater amounts		5 cents per 100 cubic feet

load is taken from the small consumer and placed on the large meter.

The diagram herewith shows graphically the costs of service under the new and old rates for metered consumers.

VALUATION OF PROPERTY

Both parties, as well as the commission, gave considerable attention to the valuation of the property. The company submitted two valuations, prepared by its president and its superintendent. The city submitted one, prepared by Dabney H. Maury, consulting engineer, of Chicago. Another was submitted by the commission's engineers this being as of June 30, 1912, while the others were as of June 30, 1913, and included certain large and important features that had been added during the interval.

The commission's valuation was \$500,000. The estimate made by Mr. Maury, which inadvertently omitted an allowance for working capital, was \$483,985, after the deduction of his estimate of the depreciation. The city's valuation included the paving over the mains and service pipes which had not been disturbed by the company in connection with its construction work, while the commission's valuation did not. The company's valuations were much larger.

The plant has been under the present ownership for more than 20 years, enabling the company to present a nearly complete financial history of its operation. The costs of building the plant and its extensions, together with the accumulated deficits in net earnings below a 7 or even a 6-per cent rate of return represented a sum considerably in excess of the commission's valuation—a sum so large, in fact, that it was hopeless to expect a return of as much as 6 per cent upon it. Compared with numerous other Wisconsin water plants of which valuations had been made by the commission, the Ashland plant showed relatively a very high valuation. At \$500,000 it represented more than \$43 per capita on the basis of the population in 1910, which was less than that in 1900. Most of the other plants referred to represented values of from \$15 to \$25 per capita. When compared on the basis of value per consumer the Ashland plant was quite similarly high. The rates to be charged for service rendered by such plants are materially influenced by such facts.

Mr. Maury used in his computations of going value a gross income of \$67,000, while the commission based the revised schedule of rates on a gross income of \$68,350. This latter figure, however, included allowance for some additional expense involved in an improvement of service ordered by the commission which was not contemplated in Mr. Maury's figure.

CITY CONSIDERS 4 PER CENT RETURN AMPLE

Although no new evidence of consequence was presented by either party at the rehearing, the city subsequently filed a written and somewhat lengthy argument, to which a written reply was made by the president of the water company. The former contended that the rates established by the order made in February were exorbitant and urged that they be revised downward. It was argued that the valuation placed on the property by the commission was much too high, and that instead of a net return of 6 per cent as contemplated in those rates, not more than 4 per cent should have been allowed to the company. It was pointed out that Government

bonds yield but 2 or 3 per cent, and that owing to the depressed conditions which had existed in Ashland for several years other private investors had suffered losses and been unable to make more than low rates of interest on their investments. It was argued that the owners of the utility in question should share in the losses suffered by the city and its people generally.

Considerable attention was given in the arguments of the city to the theories and methods of valuation and to certain items in the inventory upon which the commission had allowed more value than the estimates of cost made by Mr. Maury, particularly the items of laying mains, services and the construction of the filters. In regard to the laying of cast-iron mains the commission found, upon further investigation, that the actual costs of mains laid during the last five years, representing 4.2 per cent of the total mileage, the original judgment of the commission's engineers as represented by the unit prices used in their 1908 valuation, and those used by Mr. Maury, all justified a reduction of the amount previously allowed on this item, which was based on the revised unit prices used in the staff's valuation made in 1912. A reduction of \$9700 was made in the amount previously allowed on laying the cast-iron mains. Reductions on service connections and filters, together with a proportionate amount of the overhead general expenses, made a total reduction of about \$20,000, resulting in a revised valuation of \$480,000.

The commission further affected the amount of gross earnings to be provided by the modified schedule by temporarily reducing the rate of net return contemplated. It was plainly indicated, however, that this part of the reduction made from the former schedule would be temporary only. The hydrant rentals, or fire-protection charge, was reduced from \$24,300 to \$21,000. Approximately one-half of the increase made in February over the old flat-rate schedule for private service was also taken off.

EXTRACTS FROM RAILROAD COMMISSION'S SECOND DECISION

After answering all of the various arguments advanced in that brief, especially as to what would constitute a fair rate of net return to the owners of the utility, the commission said:

"Since this commission has been severely, not to say intemperately, criticised for its conclusions and order in its decision of Feb. 17 last, a few facts bearing upon the justice of these criticisms and the consistency of at least some of those who were responsible for them may be in point. The records in the case show among other things:

"That the city of Ashland employed an expert in the case who was said by the city—and we think justly—to be competent, honest and unbiased, and who examined the facts involved and investigated the situation generally and furnished testimony upon these points in the case, which testimony the city has also pointed to as fair and just under the circumstances;

"That this expert placed the fair value of the plant and its business, including working capital, at not far from \$495,000, while this commission placed this fair value for the purposes of this case at about \$500,000; and that this value was placed at much higher figures by the representatives of the water company;

"That the said expert placed the fair annual gross earnings of the plant at about

\$67,000, while this commission allowed an annual gross earnings of about \$68,000, including additional or new expenses involved in the improvement of service as ordered, on a schedule under which these earnings would somewhat decrease with increases in the proportion of those who used meters, and that the representatives of the water company placed the fair earnings at much higher figures;

"That the expert placed the cost of the fire-service or hydrant rentals at \$27,440 annually, while the commission allowed \$24,300 for this purpose.

SIX PER CENT RETURN NONE TOO MUCH

"That the city's expert placed the rate of return for interest and profits at 6 per cent on the fair value of the plant and its business; that in his notes on going value which were submitted in the case he stated among other things that 'over and above operating expenses, depreciation and taxes the rates charged by the waterworks for its services should yield a net return of at least 6 per cent on the gross sum of its physical property, going value and necessary operating capital'; that he 'placed this net earnings at 6 per cent instead of at a higher figure because of the fact, now generally recognized, that under the Wisconsin Commission the operation of public utilities is attended with less hazard than is usually incident to such business elsewhere';

"That this commission also allowed earnings that would yield not far from 6 per cent for interest and profits on the estimated fair value of the investment. These earnings were placed at these figures, not because it was believed that they represented the ordinary returns for capital similarly invested, or that in the long run the necessary capital and enterpriser can be had for such returns, but because the commission felt that—although little or no testimony had been introduced upon this point—the conditions in Ashland were such that for the present at least it would not be fair or to the best interest of all concerned to allow higher earnings.

WHY WISCONSIN ATTRACTS CAPITAL

"It is a fact that as has been stated by the city's expert, the operation of the public-utility law in this State has had a marked tendency to reduce the risks involved in the business and hence to lower the cost at which capital can be had in the public-utility field. It is also a fact that the public is given the benefit of these reductions, for the allowances for interest and profits which the commission includes in the cost of the service upon which the rates are based are for these reasons gradually growing smaller. We regret to say, however, that this downward tendency in the cost of obtaining capital for public utilities in this State is not always great enough to offset such abnormally low relative earnings as are sometimes encountered, or to have caused the capital and the enterpriser in this field to become so abundant that these factors can now be generally had at as low a cost as 6 per cent on the investment.

"The rates of return for interest and profits depend upon the risks involved, the state of the money market, the nature of the business and upon many other factors of this nature. Some idea of what capital and the enterpriser can now be had for by public utilities may be gleaned from the prices at which their securities are selling. During the past few years, for instance,

good bond issues have been selling on bases upon which the cost to the company, when discounts and selling expenses are taken into account, averages a little more than 6 per cent. The bonds in these cases, however, did not cover more than 80 per cent of the value of the property behind them. They were also secured by regular net earnings of the plants that amounted to about twice as much as the interest charges on the bonds. Had the bonds in these cases covered a greater proportion of the value of the plant than they did, and had the net earnings of the plant been less or more irregular than they were, then it is also certain that the bonds would have sold on bases under which the cost to the companies would have been still greater. Now if the better secured part of the capital, that which is represented by the bonds, cannot be had at a less cost than 6 per cent, it is quite obvious that that part of the capital which is represented by the stock and which is much less well secured commands in the long run much higher rates than 6 per cent. In fact the situation in this respect is such that plants whose net earnings amount to less than about 7.5 per cent on the investment find it difficult to obtain the capital needed on reasonable terms.

OPEN MARKET FIXES COST OF CAPITAL

"The cost of capital and of the enterpriser are fixed by economic forces or laws in the open market. These laws cannot be controlled either by the State, the city or this commission. Public utilities, like everybody else, must pay the market prices for what they need. Exceptions to this are only temporary in their nature. This commission has been made aware of this in more ways than one. For instance, where the existing rates for services yield less than the market rate for interest and profits, the utilities often find it impossible to obtain capital for new and much needed extensions to the plant until the commission has authorized such increases in the charges for their services that the returns are brought up to the level of the general market. In other cases, again, where the commission has happened to make so great reductions in the charges for service that the returns upon the investment were brought down below the market or reasonable level, the commission has had to retrace its steps and to raise the rates up to the requisite level before the utilities could obtain the necessary capital for such additions to the plant and to the service as were demanded and needed by the public.

"These and other facts of the kind illustrate quite fully the fact that each of the factors of production, the same as commodities and services generally, have their market prices, and that these factors, the same as commodities and services generally, cannot be had in the long run unless these prices are paid.

"The reductions which in the instant case have been made in the cost of pipe laying, services and filters and consequently in the valuation of the physical property, are mostly due to the fact that for the purposes of this case it was thought best to use the cost for these items as shown on the records of the company rather than the cost as computed from the market prices of the elements which enter into these costs. Should it be disclosed that these book costs were not correctly stated on the records of the company, then it may of course be necessary to make the proper corrections later on.

"Were the conditions involved in this case normal, the commission would not now hesitate to allow as much in the way of earnings of the plant as would be sufficient to cover the full cost of the necessary capital and managing ability as fixed in the open market under similar conditions. Such allowances in the long run are undoubtedly the best for all concerned, for under them the supply of the factors of production becomes abundant instead of restricted, and general development and prosperity is promoted rather than retarded. In fact no city in the long run can ever hope to obtain service or the factors involved in it for less than their fair market price."

Dr. Bowie Tells of Record Leveling on Geodetic Survey

SOME remarkable runs have been made by leveling parties of the U. S. Coast and Geodetic Survey. The average rate of progress for the period 1900 to 1910 was 69.5 miles per month, while for the years 1911 to 1914 inclusive the monthly rate was raised to 86 miles. The record runs of the service were discussed by Dr. William Bowie in a paper presented at the last meeting of the American Association for the Advancement of Science.

In 1905 J. B. Miller completed in one month 112 miles, which was the record at that time. In 1913 G. D. Cowie, who was on his first season of leveling, completed 176 miles in one and two-thirds months, or at the rate of 105 miles per month. In 1914 J. H. Peters completed 120 miles in July and 148.3 miles in October. His running in October was done on 24½ days, the average time of leveling per day being 6.6 hours; 327.7 miles of single line were run and there were 3156 set-ups of the instrument. The maximum running in one day was 20.3 miles in 7.0 hours. Only 10 per cent (the normal amount) of rerunning was necessary during the month because the difference between the first two runnings exceeded the allowable limit.

The average cost per mile of the U. S. Coast and Geodetic Survey work has been \$11.10 for the thirty-four seasons since 1900. The extreme range in cost per mile for the different seasons is between \$6.70 and \$16.80. The much greater percentage of the seasons' costs fall between \$9 and \$13 per mile.

THE SEWAGE Settling Tanks for the Glastonbury works at Cradlebridge, in England, were sunk as concrete monoliths through peat 30 ft. deep, according to A. P. I. Cotterell in a paper before the Somerset Surveyors' Association. Each tank has a capacity of 26,666 gal. and is designed on the sludge digestion principle with an inner chamber and a vertical-flow, annular settling tank. Great difficulties were experienced in the construction because of the unstable material. Each of the tank caissons was fitted with a cutting edge and the ground was excavated from the inside. As the structure descended the monolith was added to from above. The bottom was in soft slurry which rose in the excavation like syrup. On reaching the required depth a rough plank floor was quickly put in, stiffened by steel joists against the upward pressure. A concrete molded center was then inserted and the concrete base constructed, the water being meanwhile kept down by pumps. The tanks are now floating in the moor.

Nomographic Charts Simplify Solution of Problems in Structural Design

Diagrams for Column Formula, Impact Formula, Reinforced Concrete Beams and Deflection of Steel Beams Are Explained by R. C. Strachan and W. M. Eliot

NOMOGRAPHIC charts for the saving of time and energy in solving mathematical formulas have taken a position of importance which should be further increased by a more general knowledge of the methods of construction and use of such diagrams. There is now available a large amount of literature on the subject, the best probably being the work of Prof. M. d'Ocagne and of Prof. John B. Peddle. The following abstracts from "Nomographic Solutions for Formulas of Various Types" by R. C. Strachan printed in the "Proceedings" of the American Society of Civil Engineers

for December, 1914, page 2975, and the discussion by W. M. Eliot in the April "Proceedings," page 963, are made with particular reference to applications in structural design.

Although some of the examples here given in terms of only two or three variables can usually be plotted more simply as curves on a system of rectangular co-ordinates, they have been used here for illustration as typical of the methods for constructing these charts. Formulas with many variables or large exponents, such as occur in theoretical hydraulics, are solved quite effectively by the use of nomographic charts.

The underlying principle is that of plotting the scales representing the variables in such a way that a line crossing the scales anywhere gives a set of readings which satisfy the equation. A nomographic representative, or, more concisely, a nomograph of a formula, may be defined as a chart on which appear scales for the variables involved in the formula, their relative magnitude and relative position being such that corresponding values of the variables are found on a line crossing the scales.

ILLUSTRATIONS OF THE METHOD

Take, as a simple illustration, three parallel scales of equal parts, starting from a common base line cd , Fig. 1, and suppose the L line to be equidistant from the other two. Draw any straight line, ab , across the scales. Then

$$fg = fk + kg = M/2 + N/2$$

The figure is a nomograph of the expression $L = (M + N)/2$ and the line, ab , is an isopleth, its intersections showing by the scale readings a set of values which satisfy the equation. If $gd = cd/3$, $fg = N/3 + 2M/3$ and the nomograph represents $L = (N + 2M)/3$. If the units on the L scale are made one-half as great as those on the other scales, the nomograph represents $L = (2N + 4M)/3$.

As another illustration, in Fig. 2, let $cd = de$, and lay off the parallel scales for P and Q as shown. This is a nomograph of $P = Q/2$, and any straight line drawn from c through the scales is an isopleth. If in place of the numbers we lay off their logarithms, we may read products instead of sums; exponents may be affected by changing the distance between scales and numerical coefficients may be introduced by varying longitudinally the position of one or more scales. A straightedge may be used to indicate the position of an isopleth, or for greater ease in reading the scales a strip of transparent celluloid having a line scratched on it will be found very convenient.

Many expressions which in their usual forms appear to be hopeless may be adapted to nomographic representation by a proper transformation. It will be found that, as a rule, scales of natural numbers are suitable for formulas in which the signs $+$ and $-$ appear; and logarithmic scales are adapted to those in which quantities affected by exponents must be multiplied or divided. In many cases, however, a formula in which there is an integral exponent may be trans-

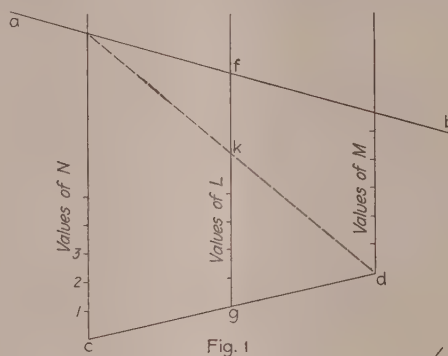


Fig. 1

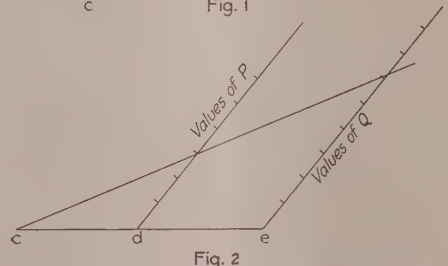


Fig. 2

FUNDAMENTAL RELATIONS IN NOMOGRAPHIC CHART CONSTRUCTION

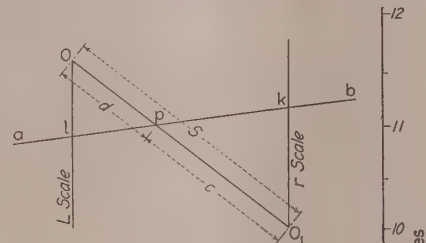


Fig. 4

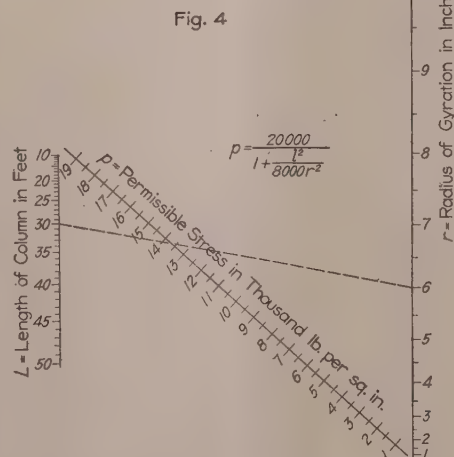


Fig. 3

CHART FOR UNIT STRESS BY GORDON COLUMN FORMULA

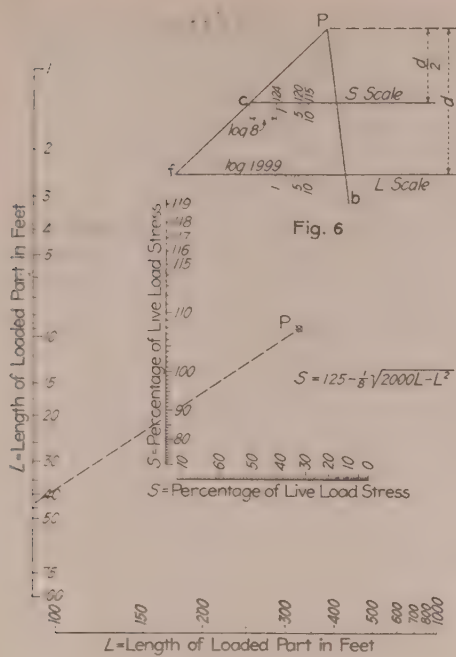


Fig. 5

CHART FOR IMPACT BY NEW YORK PUBLIC SERVICE COMMISSION FORMULA

formed so as to permit the use of natural numbers for its nomographic scales.

CHART FOR COLUMN FORMULA

The Gordon column formula, when suitably transformed, may also be adapted to nomographic representation obtained by the relation of similar triangles. The diagram, Fig. 3, gives the value of unit stress p by the formula

$$p = 20,000 / (1 + (l/r)^2 / 8000)$$

The length is usually given in feet, and therefore, inserting $12L$ for l and transforming

$$p/20,000 = r^2 / (r^2 + 0.018L^2)$$

By similar triangles, $O_k k : O_l :: c : d$, Fig. 4, therefore

$$O_k / (O_k + O_l) = c / (c + d) = c / S$$

By comparing these two equations, it is evident that S can be selected to represent 20,000 to any scale, values of O_k plotted as r^2 and O_l as $0.018L^2$, and any line ab will cut the line $O_k O_l$ at a distance c from O equal to the desired value of p . These scales must be chosen with regard to the

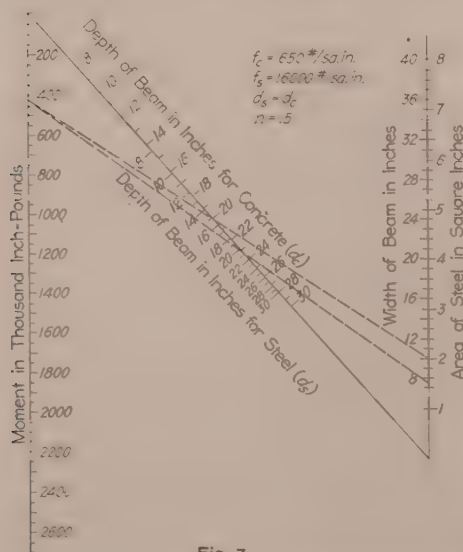


Fig. 7

precision desired in the results. The broken line on the chart shows the solution for the case of $L = 30$ ft. and $r = 6$ in.

CHART FOR IMPACT FORMULA

The percentage of live load stress to be added for the effect of impact in designing bridge trusses is specified by the Public Service Commission of the First District, New York, as

$$S = 125 - \sqrt{2000L - L^2}$$

in which S = percentage, and L = length of load producing the stress to which the percentage is to be added. If we represent $2000L - L^2$ by q , this may be written

$$125 - S = \sqrt{q/8}$$

Also, $\log(125 - S) = (\log q)/2 - \log 8$. The series of values of q taken with suitable intervals in the value of L , may be easily deduced, because, for consecutive values of L differing by unity, the consecutive values of q differ by $(2000 - 3)$, $(2000 - 5)$, $(2000 - 7)$, etc. Thus when $L = 1$, $q = 1999$; when $L = 2$, $q = 3996$, etc. Referring to Fig. 6, lay off the logarithms of q from the point f , marking one opposite $\log 1999$, 2 opposite $\log 3996$, etc.

From the extremities of this scale, when completed, draw lines to a point P , and place the S scale line parallel to the L scale line at a distance of $d/2$ from it. If a logarithmic scale of the same unit magnitude as the L scale were placed on the S scale line beginning at c , any straight line from P through the L scale would give the number corresponding to $(\log q)/2$ at the point of crossing the line S ; but by beginning at a distance of $0.908 = \log 8$ from c , the point of crossing occurs at $(\log q)/2 - \log 8$. The reading on this scale would then be $\sqrt{q/8}$, or $125 - S$. If we now number the S scale by putting 124 for 1, 123 for 2, etc., any line, Pb , is an isopleth giving scale readings for S and L which satisfy the given equation. In the chart, Fig. 5, the scales, for the sake of compactness, are turned through 90 deg. at the point L equals 100. The logarithmic unit also changes, so as to keep the graduations of the S scale large enough to be easily read. The broken line in Fig. 5 shows that when L equals 44 ft., S equals 88 per cent.

The paper also includes the construction of diagrams for $\sqrt{SA}$ in the McMath run-off formula, bending moments for pins, reinforced concrete beam formulas, and the

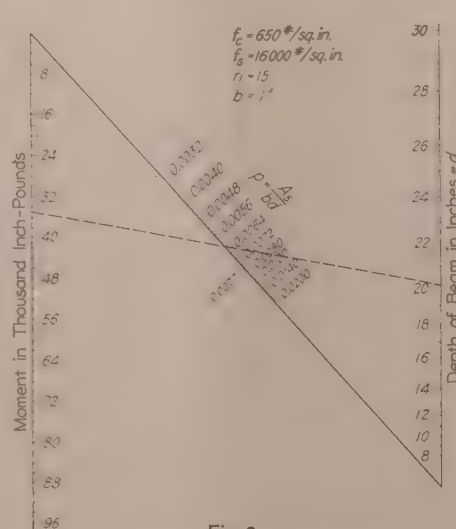


Fig. 8

CHARTS FOR REINFORCED-CONCRETE RECTANGULAR BEAM DESIGN AND INVESTIGATION

Williams-Hazen formula for velocity of discharge in pipe running full.

CHART FOR REINFORCED-CONCRETE BEAMS

W. M. Eliot, in discussing this paper in the April "Proceedings," page 965, states that he does not believe the author's chart for reinforced concrete beams will be used to any extent by engineers, as the diagrams by Arthur W. French cover the same ground in a simple manner, and are now in general use (see Transactions of the American Society of Civil Engineers, Vol. 56, page

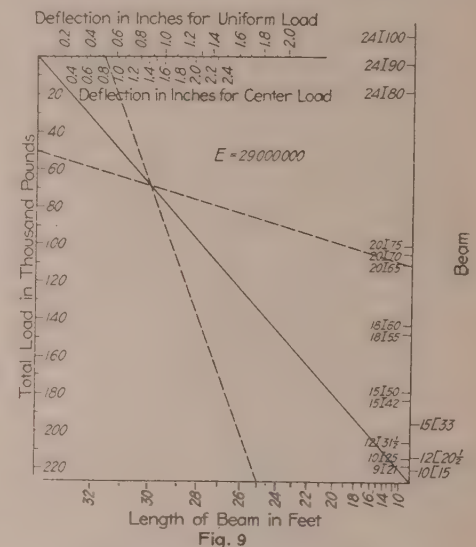


Fig. 9

CHART FOR DEFLECTION OF STEEL BEAMS

360). The two nomographs which follow, though only for stresses of 650 and 16,000 lb. per square inch on the concrete and steel, respectively, give more direct results than the one proposed by the author. The diagram, Fig. 7, gives the size of beam and area of steel required to resist a given moment, when the concrete and steel are each set to the working limit. For the case shown, a moment of 428,000 in.-lb. requires a beam 10 x 20 in. (effective depth) and an area of steel of 1.54 sq. in.

Often the size of beam is fixed, and it is desired to know the quantity of steel required for a given resisting moment. This is given by the nomograph, Fig. 8; the resisting moment is determined by the steel being stressed to the working limit for values of p less than 0.0077, and by the concrete for values of p greater than 0.0077. Given a beam, 10 x 20 in. (effective depth), to resist a moment of 350,000 in.-lb.: Place a straightedge on the moment 350,000 lb. (for 1 inch in width) and on $d = 20$; read $p = 0.0062$. The area of steel required then is equal to pbd , or 1.24 sq. in. One designing many beams can well afford to make similar nomographs for the stresses he uses, as little time is required.

CHART FOR DEFLECTION OF BEAMS

This method can be applied in the same way to more complex formulas, such as that for the deflection of beams:

$$\Delta = \frac{5WL^2}{384EI}$$

in which $E = 29,000,000$ for steel; Δ represents maximum deflection; L , span length; W , total uniform load, and I , moment of inertia. The cubes of L are used and the sizes of beams are written at their respective moments of inertia when the members are plotted. The deflections for a concen-

trated center load are similarly shown. A 20-in. I-beam of 65 lb. per foot, with a total uniform load of 50,000 lb. on a span of 25 ft. has a deflection of 0.52 in., Fig. 9. The following article by C. P. Conklin gives two other useful diagrams based upon the same methods of construction.

Nomographic Charts for Simple Beam Design

Methods for the Design or Investigation of Steel I-Beams and Rectangular Timber Beams by the Use of Diagrams

By CHARLES D. CONKLIN, JR.

Civil and Structural Engineer, Cheltenham, Pa.

THE PRINCIPLES explained in the paper by R. C. Strachan on Nomographic Charts in "Proceedings" of the American Society of Civil Engineers for December, 1914, can be easily applied to the design and investigation of timber beams and steel I-beams. The accompanying diagrams, Figs. 1 and 2, will be found to save much of the time so often spent in making computations and selecting rectangular timber beams, or looking up I-beams in handbooks.

DIAGRAM FOR STEEL BEAMS

Fig. 1 applies to simple spans uniformly loaded, and is constructed to give the required size of either standard or Bethlehem I-beams when the uniform load per foot, the span length and the allowable fiber stress are given. For example, consider a simple beam carrying 1600 lb. per foot on a 20-ft. span with an allowable unit stress of 16,000. The straight edge is placed as shown by the dash lines connecting 1600 on the left vertical line and 20 on the diagonal line for span length; the point of intersection with the vertical line for moment is then used as a center and the straight edge revolved to intersect the allowable fiber stress, 16,000, on the right vertical line. The intersection with the right diagonal line as shown then gives the required beam—either a 15-in. 45-lb. standard I-beam or a 15-in. 41-lb. Bethlehem beam. The bending moment can, of course, be read and noted if desired.

To determine the permissible load per linear foot on a beam of given size for given unit stress and span, the above method is simply reversed. It is also possible, obviously, to determine the extreme fiber stress

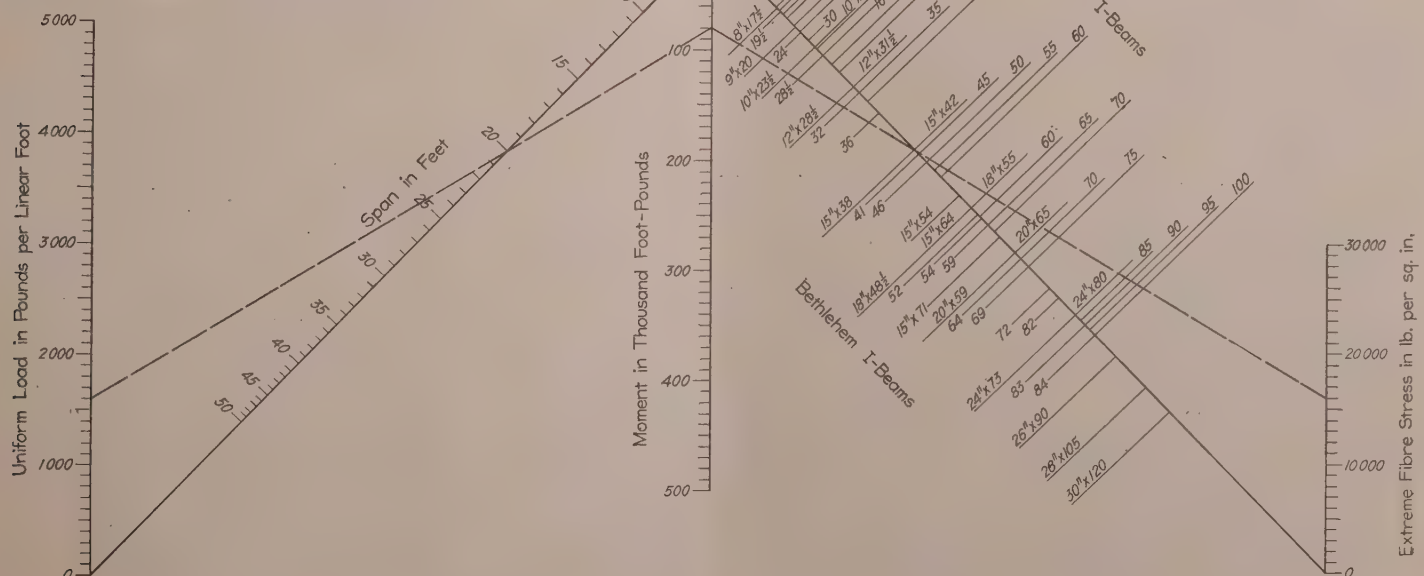


FIG. 1—CHART FOR SIMPLE BEAM BENDING MOMENT AND FOR SIZES OF STANDARD AND BETHLEHEM I-BEAMS

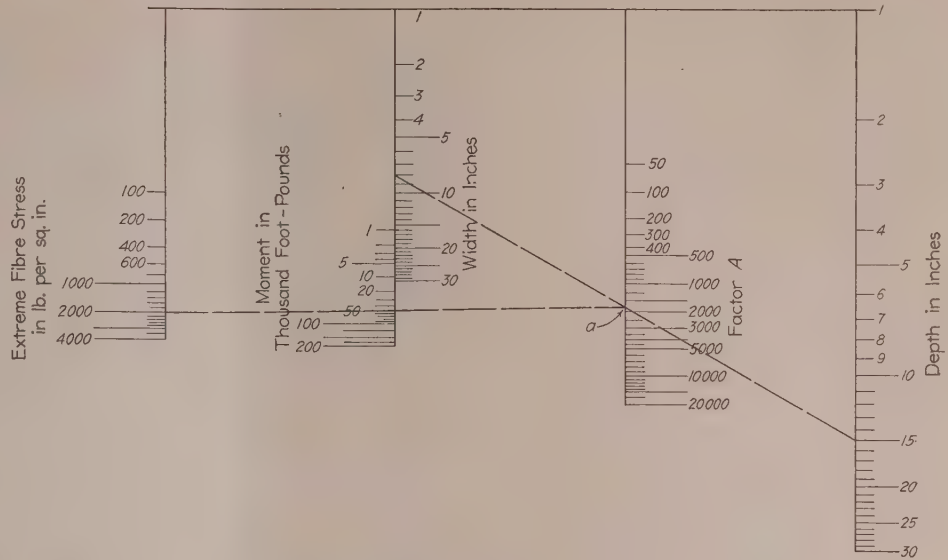


FIG. 2—CHART FOR DESIGN AND INVESTIGATION OF RECTANGULAR TIMBER BEAMS

in a given beam with given loading and span, or the maximum span for a beam of given size, load and unit stress. For the case of special loading it is only necessary to compute the maximum bending moment, and use with the moment line. The right-hand lines are then used to find the required I-beam for a given unit stress.

DIAGRAM FOR TIMBER BEAMS

The selection of rectangular timber beams to resist given bending moments is easily made by the use of Fig. 2. If the bending moment is produced by a uniform loading, its value can first be found by using Fig. 1. Knowing the allowable fiber stress, the straight edge is placed at the corresponding value on the left vertical line and on the moment on the second vertical line, and the point of its intersection with the vertical line marked "Factor A" is used to swing the straight edge to any diagonal position corresponding to the best practicable breadth and depth found on the second and fourth lines respectively. Thus for a moment of 50,000 ft.-lb. and a unit stress

of 2000 lb. the dash lines give an 8 x 15-in. beam. Any other combination of width and depth found by a straight line through the point "a" could be used.

This diagram will also give the safe moment on a given beam for a given allowable fiber stress, or the extreme fiber stress in a beam of given size for a given bending moment. Either process would, of course, be simply the reverse of the direct design method explained.

WOOD-FIBER ASPHALT PAVEMENT has been laid for a length of 605 ft. on Morris Street in Charleston, W. Va. The portable plant used had a double drum in the dryer with drafts so set that neither flame nor hot gases could come in contact with the wood fiber passing through it. Stone dust and hot asphalt were added to the wood fiber in the mixer in the usual way and the paving mixture was hauled to the work in hand carts, spread and rolled with a 10-ton roller. Then a squeegee coat and stone screenings were added and the rolling continued.

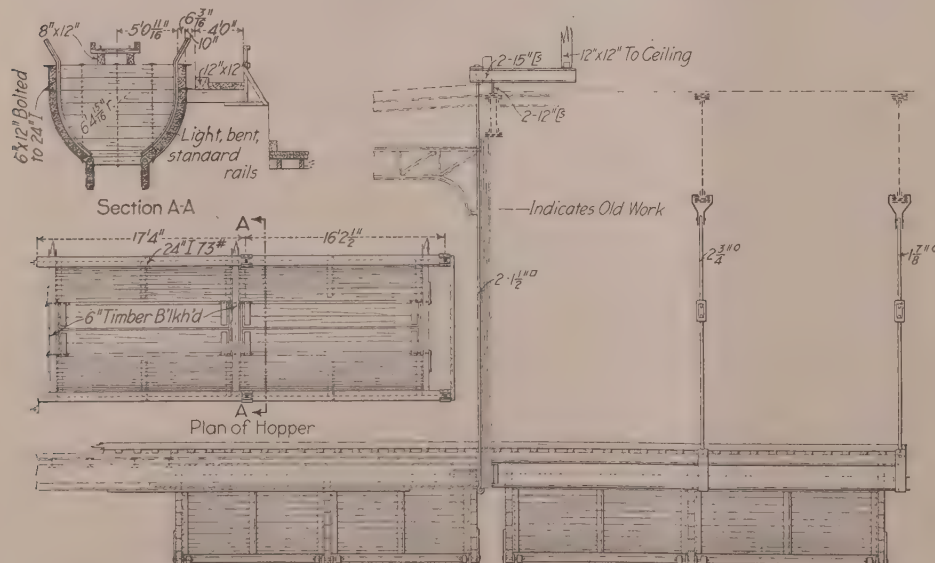
Improvements Urged in San Diego's Water Department

A NUMBER of recommendations for the improvement of the water department of San Diego, Cal., are contained in the 1914 report of Herbert R. Fay, superintendent. Among them are the following:

Funds collected by the sale of water should not be used for purposes other than waterworks improvement; when the water fund shows a surplus improve the system or reduce the rate. Meter boxes should be set or reset flush to the curb and covers of metal should replace those of wood. Motor service wagons and auto trucks should replace all horse-drawn vehicles now in the department. The weekly half-holiday now granted clerical forces in the city's employ should be extended to include all city employees. As a convenience and benefit, and in justice to the day laborer, all employees of the city, except the charter officers and those provided for by a regular monthly pay-roll, should be paid weekly and in cash. A municipal employment bureau should be maintained for the accommodation of the citizens soliciting positions and the convenience of the officials affected.

The monthly meetings held by the Department of Water should be extended to other departments of city work as they are very beneficial to the individual and conducive of good to the department as a whole. The Mayor should take the initiative in holding quarterly meetings along similar lines with all city officials for a better understanding and working condition among departments, so that loyalty, efficiency and harmony may prevail and better results be obtained in city work.

WATER-RIGHT INVESTIGATIONS IN BRITISH COLUMBIA, intended to clear up old titles, were carried on systematically last year in each of the eight engineers' districts of the Province. An official report on the work done in 1914 states that 1469 records have been confirmed, 1138 have been cancelled and 1246 are being held for further evidence on investigation, including 271 records granted for the use of Indians. There are still 2124 records which have not yet been set for a hearing, most of these being in the northern parts of the Province.



HOPPERS FOR DISPOSAL OF MUCK FROM LOWER TUNNELS ARE LINED WITH BENT RAILS, HUNG FROM FERRY HOUSE FRAME; THEY DUMP INTO SCOWS



WORKING CHAMBERS OF OLD SLIP CAISSONS HAVE REMARKABLE PLATE DECKS

Starting Six Tubes for Two New East River Subway Crossings in New York

Four Caissons Sunk, Two at Old Slip Having Four Removable Plate Circles from Which to Start Shield Tunnels—28,000-Foot Air Plant Used

THE TWO PAIRS of tunnels under the East River, New York City, from lower Manhattan to Brooklyn, for the new Interborough and Brooklyn Rapid Transit lines are being started on the Manhattan side with six tunnels, two pneumatic and four partly in solid rock, from four shafts, all sunk as pneumatic caissons. The quantity of air needed for this work has called for an electric air plant with a capacity of more than 28,000 cu. ft. of free air per minute—one of the largest construction air plants on record. The excavation from all this work is disposed of by dumping into barges at the north slip of the municipal ferry house of the line to Thirty-ninth Street, Brooklyn. This slip has been converted for the purpose, and has a dump for teams approached by an incline on which wagons are

carried on an endless chain. Also, in the space from which the ferry landing float was removed, at the upper floor level, are hoppers into which cars carrying muck from the two shafts for the two south pairs of tubes are dumping. These cars are operated on a third-rail line on a long platform, erected over the street in front of the ferry house, by electric locomotives, which later, when the elevators are installed, will be carried down into the tunnel workings.

SHAFT AND TUNNEL LAYOUT

The most southerly construction shaft is an ordinary rectangular wooden caisson sunk to rock over an open space in the Brooklyn Rapid Transit tunnels where crossovers are planned. These tunnels, and turnout tunnels which lead from them just inside the pier-head line, and turn west at Broad Street, are in rock, and, now that the shafts are sealed, air will not be required on them until this lower pair of tubes nears the middle of the river. They are being driven by the bottom-heading method. This lower shaft will contain a single long elevator car, which will hold three tunnel cars at a time. From it headings in each direction are being driven, those toward shore meeting the construction under Whitehall Street, and those toward the river joining the turnout tunnels which go up Broad Street, and continuing out to Coenties Reef.

The second shaft is the annular concrete caisson described in the Engineering Record of April 24, 1915, page 522. This is to be a permanent shaft for ventilation and emergency exit, and two drifts are being driven to connect it with the Whitehall and the Broad Street tunnels. The shaft is just south of the latter pair, and the north drift from which these tunnels will be driven is already completed.

The concrete seal of this caisson was placed by dropping moderately wet concrete

down the shafting from the air locks. From the angle of flow observed before the concrete reached the roof of the air chamber it appeared at the quarter points farthest from the two shafts to be only 6 in. lower than at the shafts. The seal obtained by the impact of the concrete falling from the top of the air shafts filled the air chamber tight to the roof, so that no grouting was required to seal completely the air chamber and the joint between the concrete and the rock in the 5-ft. space excavated below the cutting edge.

SHAFTS IN OLD SLIP

The upper pair of tunnels, in which the Seventh Avenue subway will cross the river, will have to be driven with compressed air from the start. These tubes are separated, one on each side of the street, at Old Slip and Front Street, where the two shafts to start them are being sunk. These shafts are from the designs of the Public Service Commission, are part of the permanent work, and have structural steel walls filled with concrete. On the east and west faces of each caisson, above the deck during sinking, are two circular bulkheads made of removable outside plates riveted to horizontal plate girders. One of these is clearly shown in one of the photographs.

After the caissons were landed the bottom portion of the invert within the working chamber was concreted through the air locks. The deck was then removed from each to be rebuilt above the shields are erected. The construction of these steel decks which renders this step easy is shown in one of the photographs. The circle will then be taken out of each side of each caisson, when the shields will be started under air from each shaft. These tunnels will be in difficult ground for economical progress for some distance, as the bottom of the shields will be several feet below rock surface.

The caisson on the south side of Old Slip encountered several feet of old timber grillage and a large number of piles, left from the days when this street was in fact a slip. This considerably increased the difficulty of sinking. On the north side an old boat was found in the mud, and also piles and timber grillage, though not so much of this as in the first caisson.

OVERHEAD STRUCTURE AT OLD SLIP

Each caisson has two locks and is served by two derricks. The spoil removed from these shafts is dumped from the caisson buckets against slanting boards, constructed like a half-hopper, from which it slides into cars. These are pushed by hand over hoppers on the east side of Front Street and dumped. The hoppers discharge into wagons, which, with those from other subway sections in the neighborhood for which the Flinn-O'Rourke Company has contracted, are dumped into scows at the north slip of the municipal ferry house.

DISPOSAL PLANT AT FERRY HOUSE

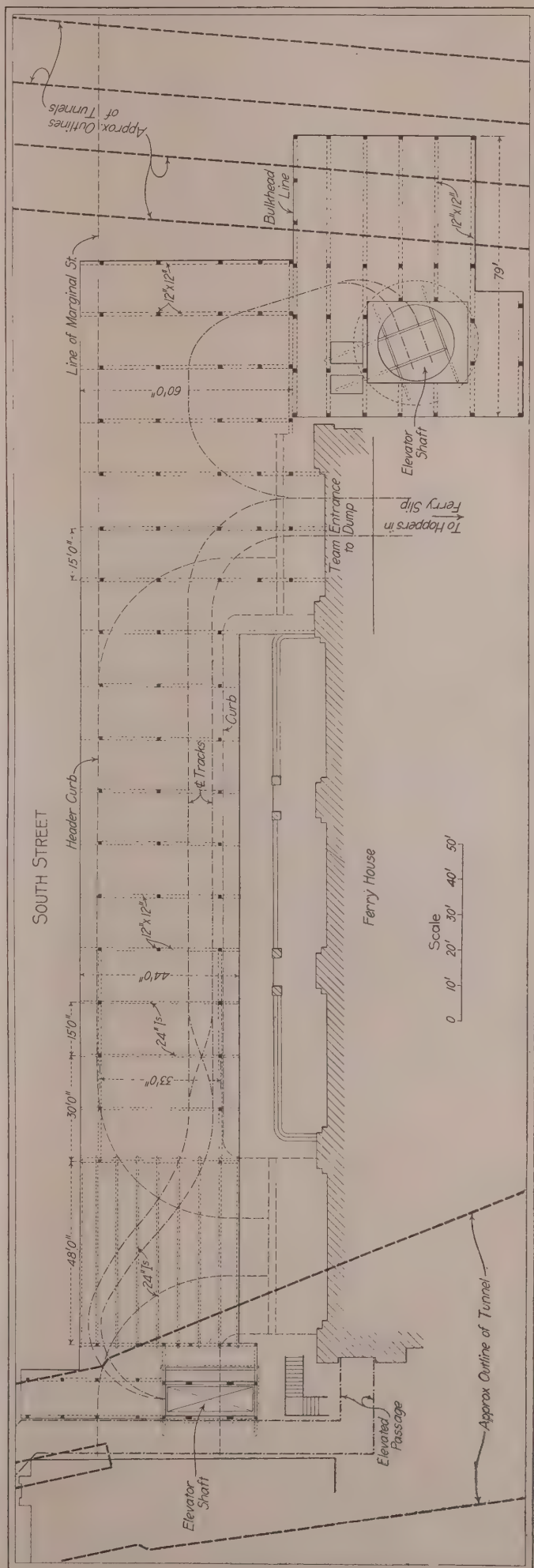
The ramp at the municipal ferry house up which teams are carried is fitted with an endless chain, the links of which consist of two flat steel bars each, and are pin-connected. Every 25 ft. this chain carries a projecting lug of steel plate. An A-frame strut made of pipe, which has plates on the end of its legs bent to fit the rear axle of the wagons, is placed, legs up on this axle, and tip on the timbers flanking the slot in which the chain runs. The first lug that

comes up catches the tip of this strut and pushes the wagon up the ramp. The chain is driven over sprocket wheels by a 25-hp motor. An electric hoist, however, is kept in reserve for use when the sprocket device is out of order. From the top of the ramp the teams drive out on a platform supported from the north side of the pile slip, and dump backward over an apron into scows inside the slip.

The cars from the electric railroad, on the elevated timber structure in front of the ferry house, which brings spoil from the shafts at Broad and Whitehall Streets, dump into round-bottomed hoppers which are suspended from the ferry-house structure in the space normally occupied by the floating bridge and gangways. To dredge out under this space so that loaded scows could be handled in it was a problem, as even after the gangways were removed there was not room to operate a boom. A drag bucket from a dredge in the slip was out-hauled into the space, and the material was scraped into the slip where a dredge could take it up. Barges can be changed under the car hoppers without disturbing those into which teams are dumping.

The tracks over these hoppers run straight through the second story of the ferry house and branch to each shaft. As cages have not yet been put in these shafts, the buckets being used to hoist the muck are dumped into the cars against dashboards as at Old Slip.

Midway between



MUCK FROM APPROACH TUNNELS IS COLLECTED BY THIRD-RAIL LOCOMOTIVES AND CARRIED OVER TEAM ENTRANCE FOR MUCK FROM OTHER SECTIONS TO DUMP IN FERRY SLIP

the two pairs of tubes, on the west side of South Street in Jeanette Park, the contractor has put up one of the largest electric air plants ever used on construction work. It includes four 6000-ft., 600-hp., double-cylinder, motor-driven machines for supplying the shafts and tunnels; two 2200-ft. motor-driven high-pressure machines, supplying air for drilling; a battery of electric pumps for circulating water and water for the drills, and a transformer station stepping current down to 6300 volts for the power house and to lower voltages for general use.

The steel-frame galvanized-iron building in which this plant is located also houses complete machine and blacksmith shops, equipped with a full line of steel-sharpening tools, drill presses, lathes and shapers, and provided with a crane for handling heavy machine parts. From this plant two 16-in. air mains run under the streets to Old Slip, and two to the shafts at Broad and Whitehall Streets. Beside these lines 6-in. high-

engineer, was incorrectly mentioned as having entire charge of the construction work. All of the work described is being done under the direction of the Public Service Com-

mission for the First District, for whom George S. Rice is engineer of the first division and William H. Snow, engineer of the section.

Literature

For the Civil Engineer and Contractor

New Publications

HUMAN NATURE AND RAILROADS. By Ivy L. Lee. Cloth, 5 1/2 x 7 1/2 in.; 129 pages. Philadelphia, E. S. Nash & Company. \$1 net.

THE CITY MANAGER. By Harry Aubrey Toulmin, Jr. Cloth 5 1/4 x 7 1/2 in.; 310 pages; tables and diagrams. New York and London, D. Appleton & Company. \$1.50 net.

CONSERVATION OF WATER BY STORAGE. By George F. Swain, professor of civil engineering, Harvard

electrical and mining engineering and, judging by the first number, should serve a very useful purpose.

SURVEYING AND BUILDING CONSTRUCTION for Agricultural Students, Land Agents and Farmers. By A. H. Haines and A. F. Hood Daniel. Cloth, 6 x 9 in.; 339 pages; illustrated. New York and London, Longmans, Green & Company. \$3 net.

An elementary text book treating English methods, and principally devoted to the subjects which give practical aid in accomplishing simple tasks in land surveying and farm building construction. It will probably be found useful by those who desire to pass the professional examinations of the Surveyors' Institution.

REPORT OF THE WATER RIGHTS BRANCH of the British Columbia Department of Lands. Paper, 7 x 10 in.; 32 pages; illustrated. Victoria, B. C., William Young, comptroller of water rights.

The detailed record of the work of the Water Rights Branch during the year ended Dec. 31, 1914, is set forth in the report. Precipitation and temperature records from all parts of the Province are given, as well as statistics covering the work done in investigating the validity of old water rights. The results of experiments on the duty of water made at the government farm in Columbia Valley are given. Each of the eight engineers' districts into which the Province is divided is represented in the report.

Books Reviewed

The Railroad Taper

Author, Lee Perkins, formerly assistant engineer, Southern Pacific lines in Arizona and Mexico. Leather, 4 1/4 x 7 in.; 356 pages; 41 illustrations. New York, John Wiley & Sons, Inc. \$2.50 net.

Reviewed by A. F. Comstock

Associate in Railway Engineering, University of Illinois, Urbana, Ill.

The transition curve, often called the spiral or spiral easement curve, but designated as the "taper" by the author, has never been standardized on American railroads (even the name has escaped standardization), although the American Railway Engineering Association, by adopting the ten-chord spiral in 1911, started a movement in that direction. The transition curve here proposed was devised by William Hood, chief engineer of the Southern Pacific railroad. It is remarkably simple, consisting of a series of compound curves increasing in curvature by arithmetic progression at intervals of 30-ft. chords (10-m chords in the metric system). The constant chord length is a distinguishing feature.

The book is essentially a set of tables, aiming to be so complete as to obviate the necessity for calculations in the field. In order to achieve this purpose the various functions are shown for almost 700 different combinations in American units of taper increment and length, and an equal number in the metric system, each occupying about fifty pages. In addition there are ten tables (188 pages) of simple curve functions, logarithms and trigonometric functions, largely borrowed from Nagle and Webb.

Besides the tables there are 62 pages of text, amply illustrated, explaining the application of the taper to numerous conditions of both new and old track. Simple trigonometric equations are used entirely, and the explanations are consistently clear



AFTER CAISSON IS SEALED DECK IS REMOVED AND RESET ABOVE PLATE CIRCLE, WHICH IS THEN REMOVED TO START SHIELD FOR DRIVING TUNNEL

pressure lines and 2-in. water lines are laid to supply the drills and shields. A 2-in. gage line from each caisson to the power house gives the exact air pressure inside the working chamber. This pressure is regulated from the central station, instead of by gage tenders—a system made possible by direct telephone communication with each shaft.

The Flinn-O'Rourke Company, Inc., are contractors for the East River tunnels. The plant layout and construction design have been under the personal direction of John F. O'Rourke, chief engineer of the company. Innis O'Rourke is general superintendent of all work on the Manhattan end of the tunnels. Owing to an oversight in the article on the Broad Street shaft referred to in the fore part of this article the name of the shaft superintendent was given instead of that of the general superintendent, and A. A. Brewer, who is assistant to the chief

University. Cloth, 7 1/4 x 10 in.; 384 pages; illustrated. New Haven, Conn., Yale University Press. \$3 net.

HIGHWAY BRIDGES AND CULVERTS. By B. K. Coghlan, associate professor of highway engineering, Agricultural and Mechanical College of Texas. Paper, 6 x 9 in.; 30 pages; illustrated. Bulletin 3, Texas Engineering Experiment Station, Austin, Texas.

BRITISH COLUMBIA HYDROGRAPHIC SURVEY, 1913. Water Resources Paper No. 8, Department of Surveys, Canada. By R. G. Swan, chief engineer, prepared under the direction of J. B. Chalmers, superintendent of Water Power Branch. Paper, 7 x 10 in.; 367 pages; illustrated; tables and maps. Ottawa, Canada, Government Printing Bureau.

THE ECONOMIES OF CONTRACTING—A Treatise for Contractors, Engineers, Manufacturers, Superintendents and Foremen Engaged in Engineering Contracting Work, Vol. II. By Daniel J. Hauer, construction economist and consulting engineer, editor of the Contractor. Cloth, 5 1/4 x 8 1/2 in.; 334 pages; illustrated. Chicago, E. H. Baumgartner, Rand-McNally Building.

EL INGENIERO Y CONTRATISTA. New monthly technical journal printed in Spanish. Paper, 12 x 9 in.; 20 pages; illustrated. El Ingeniero y Contratista, 135 Front Street, New York. \$2.50 per year. A periodical that has as its object the presenting of such features of engineering work in North America as will be of practical use to the members of the profession native to the Spanish-American countries. Its field covers the several branches of the profession—civil, mechanical,

and to the point. The illustrations are excellent. In discussing the choice of taper the importance of providing sufficient length to gain the required superelevation at a safe rate per rail length is indicated.

Maintaining the constant chord lengths of 30 ft., and 10 m, respectively, eleven different basic increments of increase of curvature are shown in the tables, beginning with 15 min. and ending with 5 deg. For each of these eleven cases are shown all of the functions (of which there are ten) required to stake out the taper. The deflection angles, central angles, offsets from tangent, long chords, co-ordinates, etc., are shown for 30-ft. chord points and for an average of some sixty intermediate lengths corresponding to intermediate degrees and fractions of a degree of main curve. By interpolation other intermediate values may be easily supplied where necessary.

As a self-contained pocketbook on the transition curve for steam railways this work deserves high rank, principally because of the unusual completeness of its tables, the simplicity of its underlying theory, and its practical applicability. The book will save much time in the field wherever this particular transition curve is in vogue.

The A. B. C. of Iron and Steel

Includes a Directory of the Iron and Steel Works and Their Products of the United States and Canada. Edited by A. O. Backert. Cloth, 8 x 11 in.; 337 pages; illustrated. Cleveland, the Penton Publishing Company.

This book is a finely illustrated descriptive text of modern methods of iron and steel manufacture, including mining operations and ore handling. Each of the eighteen chapters is the work of a writer of undisputed standing, having expert knowledge of his field. The treatment is broad and practical, omitting technical detail and designed to interest all progressive men connected with the iron and steel industry.

Among the names of the authors are several editors of trade journals, engineers connected with the steel industry, consulting engineers and one assistant professor. Short sketches of the experience and position of the authors, with their photographs, are included. The names of the late John Birkinbine, J. L. W. Birkinbine, John Howe Hall and Kenneth Seaver are among the prominent engineers who have contributed. The profuse illustrations, of which there are 222, nearly all large photographs, add greatly to the interest of the text. The statistics of the American iron and steel industry give the facts of production up to the present time, and a directory of iron and steel works and manufactures, their products and the names of their executives is also included.

Materials of Construction

Author, Adelbert P. Mills, M.S., C.E., assistant professor of materials, College of Civil Engineering, Cornell University. Cloth; 6 x 9 in.; 682 pages; illustrated. New York, John Wiley & Sons, Inc. \$4.50 net.

The most striking feature of this treatment of the important subject of materials of construction, in addition to the attempt to make it thoroughly modern, is the systematic and logical order in which each particular material or process is presented. The book is primarily a text for students of the subject, yet will be found concise and definite, and well arranged for reference

purposes. Interest is aroused by first stating the practical uses and value of the material to be described, with particular reference to engineering construction. Definitions and logical classifications as adopted in the best practice are given, followed by a description of methods of manufacture or production from natural sources. Finally, the physical and mechanical properties as determined experimentally are detailed, keeping in close relation to the uses of the material.

Results of physical tests are tabulated and, though by no means complete, are compiled from many sources of relatively recent origin, and therefore give dependable values based upon modern materials produced by modern methods of manufacture.

The text is divided into three parts (1) masonry materials, which are divided into cementing and non-cementing materials; (2) the ferrous metals, and (3) the non-ferrous metals, alloys, and timber. Each chapter is then devoted to one material, which is treated as already outlined, and divided into articles with headings facilitating reference and aiding the student. On the whole, the relative amount of space and detail given to each particular material is in good accord with its importance and value.

Results of tests of columns and the subject of reinforced concrete are not included; they are properly considered a part

of the closely related subject of strength of materials or mechanics of materials. Plain concrete is disposed of in 29 pages, but cement mortar is treated not separately but in the chapter on Portland cement. This is the only case of poor arrangement noted by the reviewer. The treatment of steel occupies 139 pages and is very complete, including 40 additional pages devoted to special alloy steels.

The treatment of the ferrous metals includes interesting illustrations of microscopic analysis and unusually complete data on magnetic properties. The subject of corrosion of iron and steel is also well treated, modern test results being cited. The omission of data on wire and wire rope, and hemp and Manila rope is unfortunate, but otherwise practically all of the materials used in engineering have been included. The important subject of proportioning concrete is given very inadequate treatment, occupying only two pages.

Specifications for materials are abstracted from the standards of National societies. The typography and mechanical features of the text are, on the whole, exceptionally good. The book should prove to be a valuable reference work for engineers who desire concise and clear treatment of the subject of the manufacture, physical properties, and uses of modern engineering materials. It is also an excellent textbook.

Letters to the Editor

Comment on matters of interest to engineers and contractors will be welcomed

Economic Side of Sand Testing

SIR: Our attention has been called to a clerical error in the first article of our series on sands, published in your issue of June 12, page 734, whereby the cost of blending was placed at \$9000 in place of \$900. This would make the apparent saving \$21,380 in place of \$13,280, as stated.

NATHAN C. JOHNSON.
CLOYD M. CHAPMAN.

New York City.

Refuse Incinerator Guarantees Too Strict for Fulfilment

SIR: I have read the article on "Refuse Incinerator Guarantees Are Too Strict for Practical Fulfilment" in the Engineering Record of June 19, page 777. The fact that two cities, Atlanta and San Francisco, have failed to accept refuse destructors on the ground that they did not meet the guaranteed test conditions does not prove that the guarantees in themselves were too strict or impossible of fulfilment. In both cities it appears that a change of administration occurred between the award of the contracts and the test of the furnaces, and it has been rumored that the new administration was not in accord with the plans of the outgoing officials, a condition which quite often happens in American cities. Under such circumstances there is little doubt that even ordinary contracts can be so interpreted as to make compliance there-with very difficult.

The usual guarantees: (1) That no nuisance shall be created in the normal operation of the plant; (2) that no odors,

noxious gases, smoke or dust shall escape from the building or chimney; (3) that the temperature, in the combustion chamber, shall at no time fall below 1250 deg. Fahr.; and (4) that the residue from furnaces shall be thoroughly burned, hard and free from organic matter—are not by any means impossible of fulfilment if smoke and organic matter are properly defined. In fact, any refuse furnace located in a settled community must meet these conditions to continue in every-day operation. Otherwise one of the main advantages of mixed refuse destructors—their location within easy hauling distance of populated sections—would be nullified and the plants would be closed on the ground of nuisance.

The assumption that liberal interpretation by city officials occurred in all cases, except possibly Atlanta and San Francisco, is not borne out by facts. Neither is it at all apparent that excessive guarantees were forced into the specifications by public opinion, though it is doubtless true that the city engineers protected the municipality by insisting upon such guarantees as would normally provide a nuisance-free refuse disposal works.

It is true that some contracts for refuse destructors have required guarantees of steam production, cost of operation, and temperatures, in addition to guarantees against nuisance, and these additional requirements depended upon other factors than furnace design alone, thus obligating contractors to meet conditions over which they could have no control.

The article as a whole should have a beneficial effect in calling attention to the danger of departing from practical guaran-

tees required from furnace builders, but if the writer's information be correct the two cases cited, Atlanta and San Francisco, only prove that a change of administration and policy in American cities very often results in legal difficulties and possible losses to the contractors or the municipality.

JOHN T. FETHERSTON,
Commissioner, Department of Street
Cleaning.
New York City.

"Sewage Purification and Disposal"

SIR: Some time ago you published a review of Kirshaw's "Sewage Purification and Disposal," which appears over the imprint of the Cambridge University Press, of which we are the American agents. In it you quoted the price as \$1.50. This should be \$3.75. We would esteem it a favor if you could call attention to the error. We assume this will be a favor to your readers as well as to ourselves.

G. P. PUTNAM'S SONS.
New York City.

Floor Clips to Be Used in Sheepshead Bay Speedway

SIR: In your issue of June 12, page 731, an editorial on automobile speedways states that the wooden flooring of the New York track is not attached in any way to the supports, and for that reason invites disaster should the wind pressure ever exceed the dead weight of the floor.

I should like to call your attention to the detail shown on the general plan which we sent you, calling for bent clips attached to the flooring by lag screws and bent under the beam flanges. Evidently this was an oversight on your part, since this feature is not covered in the cuts accompanying the article.

Will you kindly make note of this matter in your next issue so that the public will not pass unfavorable criticism? I might add that since the wind cannot get under the flooring on the straightaways, such precaution is not there necessary.

H. B. THORN,
Assistant Engineer, Sheepshead Bay Speedway Corporation.

Sheepshead Bay, N. Y.

[The Engineering Record understood that it had been decided to omit these clips.—EDITOR.]

Bamboo Waterwheel Used for Philippine Irrigation

SIR: It is probable that the first waterwheels built by primitive man were of the type known to the engineers as a current wheel. There are today many thousands of these wheels still in use among the peoples of the East whose civilization has advanced but little since the age of written records.

The accompanying illustration shows one of these primitive wheels similar to numbers that are installed on the island of Luzon, P. I. The entire wheel, including the shaft, is made of bamboo. It is about 10 ft. in diameter and has paddles 2 ft. wide. The paddles are made from split bamboo, woven into a coarse fabric.

This wheel is used for lifting irrigating water above the level of the stream bank and has attached to its periphery a number of buckets made of a single joint of bamboo. These carry the water to the top

of the wheel and dump it into a flume made of split bamboo trunks. The hubs of the wheel are merely the lashings that hold its spokes in place, while the bearings are simply two crossed bamboo sticks; the lower ends thrust into the mud of the river, the upper ends lashed together with thongs. To increase the head a wing dam made of grass and bamboo is built on either side of the wheel.

This wheel, silhouetted against the sky, is as delicate as the lacework of a spiderweb, yet it goes turning merrily around, squeaking like a wheelbarrow, but irrigating a native patch of sugar cane or rice as effectually as the most modern pump would do.

This wheel runs from three and a half to four revolutions per minute, dependent on the stage of the river, and lifts about twenty gallons of water at a maximum speed into the flume. The quantity of water handled



IN THE PHILIPPINES BAMBOO WHEELS SUPPLY WATER FOR IRRIGATION

in 24 hours, nearly 30,000 gal., is really quite remarkable when the fraility of its construction is given consideration.

I. W. SWAREN.

Hayward, Cal.

Lettering Land Sections for Federal Valuation Maps

SIR: The making of railroad maps for the Government, under the Federal Valuation Act, and in accordance with the detailed instructions of the map order issued by the Interstate Commerce Commission, has brought to the attention of many engineers all over the country a number of important points about drafting, which have heretofore been overlooked by the majority, and heads of departments must now make decisions as to conventionalities on drawings which heretofore were too often left to the discretion of the draftsman himself.

The map order requires that all railroad lines be plotted from left to right, continuously between termini of main line or branch, and it may be inferred that the origin point shall be the principal terminus, from which the mileage is figured. Now, in the case of roads running westward from the main terminus, in order to make the lettering of all features shown read from left to right, or the bottom side upward, it is necessary to reverse the lettering of such features as town blocks, lots, streams and watercourses from the usual system, so that they will read from north to south instead of from south to north.

There may be no serious reason to dis-

sent from this. However, in the case of original Government surveys, where the township and section system is used, we immediately encounter confusion when we attempt to reverse the lettering at the centers and corners of the sections; for we have accustomed ourselves to referring to the "northwest quarter of the southeast quarter" or the "south half of the northeast quarter" by first turning the plat to read in its true direction, north, which, in turn, we have also accustomed ourselves to know by the position of the numbers, such as section 1 at the right-hand upper corner of the township, section 2 just left of it, etc.

Approximately three-fourths of the area of our United States is surveyed by this system; and real-estate men, timber men and miners, to say nothing of surveyors and engineers, can always get their whereabouts easily in any part of the country by

following this designation. Rarely, if ever, does one refer to a direction arrow on the map, if the section lines stand out boldly enough. In fact the custom of using the section lines on maps to get direction has become so universal that they have, in a way, taken the place of the arrow pointing north, and, if custom makes rule, then a draftsman has no more right to alter the lettering of sections from a position reading north than he has to change the direction arrow sideways or upside down. In the case of railroad lines mentioned above, the lettering of the section numbers must then read opposite to the other features. Awkward as this may seem, it appears to the writer better than upsetting a long-established custom.

L. W. DUFFEE, C. E.

Mobile, Ala.

EIGHTY MILLION BOARD FEET of lumber were used in the construction of the Panama-Pacific International Exposition, according to a paper read by A. H. Markwart before the San Francisco Association of Members of the American Society of Civil Engineers. Other quantities were 130,000 ft. of sewer pipe, 850 tons of high-pressure water mains, 420 tons of low-pressure mains, 135,000 cu. yd. of macadam, 361,000 sq. yd. of asphaltic pavements, 8000 cu. yd. of concrete, 8 miles of electric duct, 70,000 ft. of high-pressure gas mains, 33 miles of electric cables and overhead power lines, 400 miles of telephone wire, 6200 tons of bolts, rods and plates, 3500 tons of structural steel and 800,000 ft. of timber piling.

HINTS FOR THE CONTRACTOR

Details Which Save Time and Labor on Construction Work

Other articles in this issue of interest to contractors and construction engineers are indexed in the Table of Contents

[Contributions to this section are solicited, and if found available will be paid for. They must be SHORT, and should be accompanied, if possible, by photographs or sketches.—EDITOR.]

Idle Steam Shovel Is Made Over Into a Derrick Car

By C. A. PECK

Rivers, Harbors and Bridges Commission, New London, Conn.

IN the construction of the steamship terminal at New London, Conn., the New England Construction Company made a derrick car out of a steam shovel at comparatively slight expense. The deck of pier 1 is made of reinforced-concrete sections about 22 x 6 ft., which weigh approximately 7 tons each. These sections, about 700 in number, were cast and cured in a yard until the pile clumps were ready to receive them. The units were then transferred from the yard



STEAM-SHOVEL DERRICK CAR SETS CONCRETE SLABS FOR PIER FLOOR

to the pier on flat cars, lifted by the remodeled steam shovel, and placed on cast-iron bearing plates set to receive them.

This steam shovel had been employed on dry excavation for part of the work. Its remodeling into a traveling crane was accomplished by dismantling the steel crane and the bucket and setting a 12 x 12-in. timber boom 33 ft. long in the crane step. This boom was guyed back to the A-frame with two 1½-in. plow-steel cables. A 6-part load fall was run from the hoisting drum, and a small chain and two blocks on each side substituted for the regular swinging gear. The swinging gear was rigged so as to provide for slow and easy motions, since the units had to be set within ¼-in. of the required position.

This plant proved to be efficient for the work, and was a material saving for the contractor, since it did away with special equipment that would otherwise have been needed, and put to work a steam shovel which would otherwise have been idle.

Shaken Bags Yield Five Sacks of Cement in Every Thousand

BY MECHANICALLY shaking cement sacks the Chicago, Rock Island & Pacific Railway is recovering five sacks of cement out of every 1000 sacks shaken on its Chicago track elevation work. Two men clean 2000 sacks a day, including loading and unloading, which would have to be done whether the sacks were beaten or not. The Century bag cleaner used consists of an iron barrel, with an arm inside on which two metal beaters are attached. The arm is geared to a crank. The sack is slipped over the beaters and the crank turned. Cement is collected in a bin under the barrel.

When the track elevation engineer obtains data on loss of cement per sack, number of torn sacks, loss in sacks, and other information he feels that he will have enough data to determine whether or not to use bulk cement.

Steel Skip, Built for Subway Work, Used as Clamshell

ONE OF the accompanying photographs shows a 2-line bottom-opening dump-bucket, largely employed for disposing of subway excavation in New York City, being used as a grab bucket. The other photograph shows a chain hitch, used at the dock in dumping these buckets into scows, which does away with the use of a hook. The bucket has no closing mechanism, but remains closed from the weight of its load when suspended by the two hinges in the upper edges of the leaves. To dump, it is

picked up on a second line attached to rings at the center of the bottom edge of each leaf.

After pumping out the cofferdam for the 46th Street pier, Holbrook, Cabot & Rollins, the contractors, encountered a stream of semi-liquid mud several feet deep along the toe of the rock fill of the river arm, which had not been removed by previous



CHAIN HITCH ON KNOB OF STRAP BELOW BAIL AVOIDS USE OF HOOK

dredging. They found that these buckets, when let down open in this mud and picked up would close of their own weight, digging a full load of this material. The buckets operate even faster than an ordinary grab bucket, as the two leaves come together almost instantly in the soft mud, and the time required to close an ordinary bucket is saved.

The chain hitch shown in the other photo-



BUCKET WITHOUT CLOSING MECHANISM DIGS SOFT MUD AT RAPID RATE

graph is made by slipping the chain through the shackle on the bucket, and putting the large ring on the end of the chain over the lug riveted on the strap hanging from the bail. The long axis of this lug is horizontal, and as the link on the end of the chain hangs vertical when the bucket is raised, the hitch cannot come undone. It requires no more time than hooking an ordinary hook in the shackle. The bail and chains remain on the unloading derrick at the dock, and the skips are hauled from the subway work on wagons or automobile trucks.

[This bucket is the same as that designed by George Perrine, now assistant tunnel engineer of the Rapid Transit Subway Construction Company, and used by the United Engineering Company, on the construction of the Pennsylvania Tunnels.—EDITOR.]

Kansas City Re-uses Broken Concrete as Aggregate for Paving

IN REPAVING Main Street, Kansas City, this spring the aggregate for the concrete foundation was old concrete broken up into $\frac{1}{4}$ to 2 $\frac{1}{2}$ -in. sizes. Many of the former



BROKEN CONCRETE USED FOR AGGREGATE

foundations were of natural cement and the specifications called for repaving with a new foundation, 8 in. thick.

The man shown in the photograph is breaking concrete into aggregate sizes. The material is then forked into wagons and again from points near the mixer it is forked into wheelbarrows. These forkings removed the small amount of dust and fine material made by breaking.

As to strength, Clark R. Mandigo, assistant city engineer, states that several samples of concrete taken direct from the mixer and placed in 8 x 16-in. cylindrical molds were tested for compression. Twelve molds were filled for each sample and on 28-day tests this 1:3:6 concrete showed an average crushing strength of 1260 lb. per square inch. This figure is practically as high as freshly broken stone gave under like conditions.

Permanent Runways on Gondolas Cut Concrete Cost 20 Per Cent

BY BUILDING permanent runways on their gondola cars used for hauling stone and sand in connection with Chicago track elevation the Chicago, Rock Island & Pacific engineers have reduced concrete mixing costs 20 per cent below the figures obtained when temporary runways were employed. The decrease in cost is attributed to the time saved in not having to remove and replace runways after unloading the cars.



RUNWAYS REMAIN ON THESE CARS, WHICH WERE ASSIGNED TO CARRYING CONCRETE MATERIALS, FOR THE LIFE OF THE JOB

The side runways are 30 in. wide and there are six 24-in. cross runways per car. The mixer is located on a car near the spouting tower with the stone and sand cars in line behind. Iron aprons hinged on the car ends connect the runways of adjoining cars. The stone and sand wheelers leave their empty wheelbarrows on the cross runways and pick up those which have been freshly loaded. Six men per car are kept busy shoveling. A continuous file of nine sand and twenty-four stone wheelers makes a continuous circuit between car and mixer. Cement is added at the mixer from a storage platform.

J. M. Weir, cost engineer, states that in addition to cutting costs the arrangement has aided in getting a greater efficiency and ease of movement out of the men. N. D. Dawson, gang foreman, using a $\frac{3}{4}$ -cu. yd. mixer, placed 256 cu. yd. of concrete in a ten-hour day.

Well Built Field Offices Succeed the Contractor's Shack

NO CONTRACTOR'S field office can be a thing of beauty, because it must always be a thing out of place. The office in the illustration, however, shows what is being done to improve the appearance of contractors' field quarters on large metropolitan contracts, making them less of an eyesore and inconvenience to the public in

whose way they must be built. This is the office of Frederick L. Cranford, Inc., and is on Mail Street over the sidewalk bounding City Hall Park, New York City. It is raised above the sidewalk on surfaced and painted timber posts, and scarcely interferes with street traffic. In addition to being less unsightly than the time-honored "shack," buildings of this kind, a number of which have been put up on New York subway work, make things much more comfortable for the field force, and help the efficiency of the field office men, beside affording the contractor a good advertisement to the public.

Suitable Tamping Prevents Misfires

IN SHOOTING to spring holes, tamping them by filling them with water is often preferable to using clay or other material, according to the "DuPont Magazine." Water, however, is not usually anything like as effective a tamping material as sand or clay. Where gravel, tailings or rock dust is used as a tamping material it may be first packed into little bags with economy to prevent cutting fuses and scraping the insulation off battery wires. Misfires often result from this cause. Contractors, however, are generally alive to the advantages of a suitable tamping material, and often buy sand for the purpose, where it cannot be obtained in any other way.



APPEARANCE OF THIS FIELD OFFICE IS A STANDING RECOMMENDATION TO THE PUBLIC OF THE CONTRACTOR WHO BUILT IT

NEWS OF THE WEEK

Passing Events in the Civil Engineering and Contracting Fields

Steinway and Fourth Avenue Subways Open

New York Public Service Commission Brings Order and Operation out of Chaotic Conditions Originating 28 Years Ago

The first official train was run over the Fourth Avenue Subway from the Municipal Building in New York City to Coney Island on June 19. Three days later the Steinway, or Belmont, tunnel under the East River from the Grand Central Station to Long Island City was formally put in service. The history of these lines is a long one. Out of the much-involved condition into which these two badly-needed lines had fallen, the present Public Service Commission, of which Alfred Craven is chief engineer, and Robert Ridgeway engineer of subway construction, has brought order, reconstruction and operation.

Fourth Avenue Project Ten Years Old

The first steps for the Fourth Avenue subway were taken in 1905, when the old Board of Rapid Transit Commissioners adopted the original route. By 1907 preliminary plans had been completed under George F. Rice, chief engineer, after the Appellate Division of the Supreme Court had ordered the construction, and overruled property owners who refused to surrender right of way. On July 1, 1907, the Public Service Commission, with Henry B. Seaman as chief engineer, went into office. After holding public hearings on the form of contracts, and completing a revision of the plans, the contracts were sent to the Board of Estimate, which approved them on March 27, 1908. Bids were received May 8, and contracts awarded May 22, 1908. The amount of the contracts awarded exceeded \$15,800,000, and Comptroller Metz refused to approve them, as this additional sum was held to exceed the city's borrowing power. A taxpayer's suit to test this opinion of the Comptroller resulted in an injunction which held up work until October, 1909. Meanwhile a referee had been appointed by the Supreme Court to report on the city's debt limit. His report, adding \$54,000,000 to the city's legal borrowing power, resulted in the dissolution of the injunction. The contracts were approved Oct. 29, 1909, and all were signed by the original successful bidders within ten days. Work was started in November of the same year.

Negotiations which resulted in the signing of the dual system contracts in March, 1913, were begun soon after this by the Public Service Commission. During this period plans for extending the Fourth Avenue Subway to Eighty-sixth Street, Brooklyn, and connecting it with two new East River tunnels and with one surface and two elevated lines to Coney Island were adopted.

Two tracks have been completed from the Municipal Building to Sixty-fourth Street, Brooklyn, where they connect with the local tracks of the rebuilt Sea Beach line. These tracks will be operated for local service for the present, full four-track operation following the completion of the dual system. Clearances in this subway are larger than in the existing lines, and trains of eight wide, large-capacity cars will be run in express service. Local platforms accommodate six cars. The completed line will cost the city about \$30,000,000.

Steinway Tunnel Dates Back to 1887

The Steinway tunnel has had an even longer and more complicated history. The New York & Long Island Railroad was incorporated to construct it, with connections under Manhattan and Long Island City, in 1887. By May, 1892, the consent of the then existing cities had

been obtained, and excavation was started by the Inter-Island Construction Company. An explosion which occurred the following December caused the work to be abandoned for nearly thirteen years.

Meanwhile the time limit for placing the road in operation had expired. Relying on a series of acts by the State Legislature for an extension, the Interborough Rapid Transit Company bought control of the railroad and let a contract for its completion to the Degnon Contracting Company on June 12, 1905. In spite of the most energetic efforts, the year and a half remaining before the expiration of the extended time limit, on Jan. 1, 1907, did not suffice to put the road in operation. A long period of litigation followed, in the course of which the property reverted to the trustees of the original company, who had no power to operate the railroad.

Finally, in July, 1913, after much negotiation, the Interborough procured an assignment from the trustees, and reassigned the

Lieut. Mears Reports First Work on Alaska Railroad

Preliminary Base at Ship Creek—Scows Transported from Seattle—400 Stationmen at Work—Force Soon to Be Quadrupled

Operations have been begun upon the construction of the Government railroad in Alaska. The preliminary base of operations is at Ship Creek, on Cook's Inlet. Thence, from tidewater, coal from the Matanuska field, in the interior, is expected to be shipped southward during the greater part of every year.

A preliminary report on the work at Ship Creek has been received by the Secretary of the Interior from Lieutenant Mears, member of the Alaskan Engineering Commission. Lieutenant Mears arrived at Ship Creek April 26, with a force of engineers and the necessary assistants, and began immediately the



FIRST WORK ON ALASKA RAILROAD—STARTING WATER TERMINAL AT SHIP CREEK

road to the city, receiving as consideration credit for \$3,000,000 of its contribution to the construction of the dual system.

The road as first built consisted of two single-track tunnels extending from a loop at Forty-second Street and Park Avenue, Manhattan, under the East River to Fourth Street and Van Alst Avenue in the Borough of Queens. Under a new contract with the Rapid Transit Subway Construction Company, let by the Public Service Commission, the tunnel was reconstructed in several details, chief of which was the uniting of the two tubes into a single 41-ft. arch construction 200 ft. long for a crossover between First Avenue and the East River.

The tunnel is to be extended to connect with the southerly tracks of the present subway under Forty-second Street, and to connect with the Astoria and Corona Elevated lines in the Borough of Queens. While these connections are being finished, temporary operation from Long Island to Manhattan has been started on the reconstructed part of the old line. When the dual system is put in operation, and the present Fourth Avenue trains diverted up Lexington Avenue, trains from Corona and Astoria will run over the Steinway route to Times Square, transferring passengers to all three of the new Manhattan subways. The new route will be known as the Queensborough subway.

Railroad into Florida Everglades

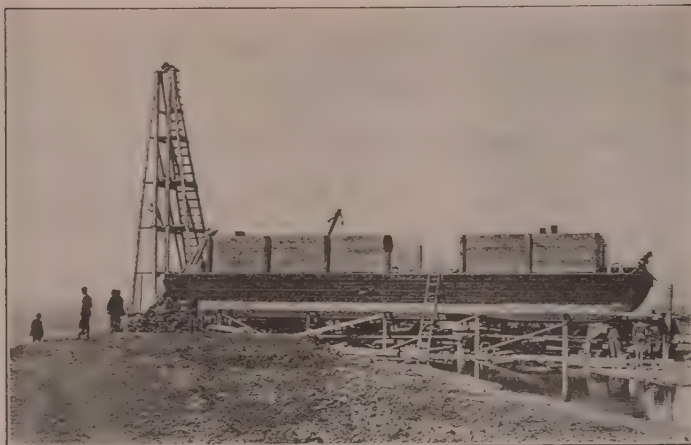
A gold spike, to hold the first rail laid in the new Palm Beach and Everglades Railway, in Florida, was driven June 17.

landing of materials and supplies for the work of construction. His report reads in part as follows:

"I brought up with me a complete pile-driver outfit and an experienced crew and started them to work as soon as the equipment could be landed and set in place. We now have the dock practically completed on the right bank of Ship Creek, near the mouth. This dock is equipped with a 15-ton stiffleg derrick operated by hoisting engine, which takes the loads out of the scows in nets or large packages and places them on the dock or flat car. I constructed what is called a 'gridiron' with pile foundation, to furnish level bases for the scows to rest upon when lying at the dock at low tide, and by this method we are enabled to unload our lighters at all stages of the tide.

Scows Brought from Seattle

"Realizing the situation at Ship Creek I made definite arrangements before I left Seattle to provide the necessary lighters and scows to handle freight from ship to shore. I knew there would be heavy demurrage, \$150 to \$200 a day, on any freighters which were held at Ship Creek longer than the accustomed time, and I also knew that a private company had provided a big barge, a floating dock, and would charge the commission \$2 a ton for every ton of freight which passed over their barge. I therefore purchased a 1000-ton barge from a towboat company in Seattle and had it delivered at Ship Creek at their risk, the price to be paid upon receipt. I loaded on this big scow three smaller scows secured from the Puget Sound Navy Yard and also shipped up, knocked down, one 200-ton scow, built by



200-TON SCOW, SHIPPED KNOCKED DOWN ON LARGER SCOW AND TEMPORARY DOCK AND WAREHOUSE AT SHIP CREEK, ALASKA RAILROAD



the Seattle Dry Dock Construction Company. This gave me a floating dock, which enabled a ship to discharge its cargo, and also a fleet of lighters with which to transfer the cargo from the ship to the shore. We have had no demurrage to pay. On May 26th the steamship 'San Ramon' came into the harbor with 912,000 ft. b. m. of lumber, and we discharged this cargo in three days, by working night and day.

500 Men at Work

"We have now contracted with about 400 stationmen and are employing about 100 men on force account handling the terminal work and constructing wagon roads. I expect to rapidly increase this force to 1500 or 2000 men as fast as material and supplies can be shipped in here to accommodate that number. By utilizing water transportation along the east side of Knik Arm we are able to attack the line at various points. We already have an active construction camp at Eagle River, a point 12 miles up the coast, and another has been started at Peters Creek, a point about 10 miles further north. We expect to continue this system of establishing camps along the tidewater, close to the line, as fast as the final location is completed and the necessary construction arrangements made.

"All of our work is being done by stationmen on a unit basis. Numerous gangs of stationmen have moved into Ship Creek seeking work on the railroad. We have had no difficulty whatsoever in securing all of the stationmen that are required. In fact, they have been coming in much faster than we could place them."

Professor Merriman Elected President of the A. S. T. M.

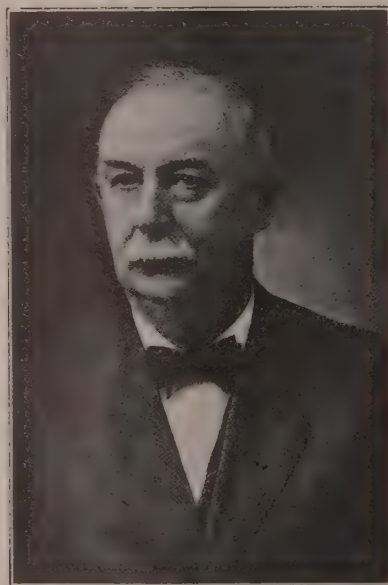
In recognition of his active interest for the past seventeen years in the work of the association, Prof. Mansfield Merriman was elected president of the American Society for Testing Materials at its annual convention in Atlantic City this week. Professor Merriman was one of the original organizers of the American section of the International Association for Testing Materials, and held the office of chairman of that organization for two years, from the time of its organization in June, 1898, to 1900. He was therefore one of the charter members of the American society at the time of the re-organization in 1902. He was born in 1848 at Southington, Conn., and spent his early years in the varied occupations of a farmer's boy. At the age of seventeen he became interested in mathematics, and by self-study was enabled to do land surveying in his native town. He also taught a country school for one season and worked for a year in a country printing office.

During this time he prepared himself to enter the Sheffield Scientific School of Yale University, from which he was graduated in 1871. After graduation he was employed in the U. S. Engineer Corps, in town surveying, and in

bridge construction. He also spent a half year in Germany. In 1874 he became an instructor in the Sheffield Scientific School, in connection with which he pursued a post-graduate course, receiving the degree of Doctor of Philosophy in 1876. In 1878, he was called to Lehigh University to fill the chair of civil engineering, where he later carried on many investigations relating to the materials of engineering.

Professor Merriman is the author of many well-known and widely-used text-books, one of

Elected President of the American Society for Testing Materials



PROFESSOR MANSFIELD MERRIMAN

which has been translated into Spanish and one into Japanese, and has written many papers read before societies and published in engineering journals. He is a member of various national societies. The honorary degree of Doctor of Science was conferred upon him in 1906 by the University of Pennsylvania, and the degree of LL.D. by Lehigh University in 1913. Since his retirement from Lehigh, in 1907, he has been engaged in consulting practice in New York City and also as editor-in-chief of the American Civil Engineer's Pocket Book, first issued in 1911 and revised in 1913.

Other Officers

The other officers elected by the American Society for Testing Materials were: Vice-president, Gen. William H. Bixby, former chief of engineers, U. S. Army; executive committee, James H. Gibboney, chief chemist, Norfolk &

Western Railway; Prof. W. K. Hatt, Purdue University; J. A. Mathews, general superintendent, Halcomb Steel Company; and Dean Edward Orton, Jr., of Ohio State University.

British Columbia's First North and South Railroad Nears Completion

Construction is nearly finished on the Pacific Great Eastern Railway which is to link the new Grand Trunk Pacific Railway with Vancouver. The new line runs north from Vancouver 477.7 miles to connect at Fort George with the transcontinental line, and will make it possible to ship from the interior provinces to tidewater near Vancouver with practically the same mileage as by way of Prince Rupert.

On June first it was officially stated that on the 438-mile stretch of the Pacific Great Eastern between tidewater at Squamish and Fort George, 98 per cent of the grading had been completed and the work of tracklaying, ballasting and bridge erection was under way. A daily train service has been established between Squamish, 39.7 miles from Vancouver, and railhead at Mile 123. Of the 39.7 miles between Vancouver and Squamish, 12.7 miles are already completed and in operation while grading has not commenced on the remaining 27 miles. Editorial comment on this new railroad appears in this issue.

275-Mile Kettle Valley Railroad, in British Columbia, Completed

The 275-mile Kettle Valley Railroad, which opens a new, direct route from the Coast to the Kootenay district of British Columbia, has just been completed after five years of construction work. The event was celebrated by a banquet at Penticton, B. C., attended by a large number of prominent railroad and Government officials. Their comments emphasized the great economic advantage of the short line from the agricultural and mining districts of the interior direct to the coast.

The Kettle Valley Railway company is a subsidiary of the Canadian Pacific Railway, whose main line it joins at Hope in the Fraser river canon, 89 miles east of Vancouver. The eastern terminus of the new route to the Kootenays is at Midway, B. C., on the international boundary and which is also on the terminus of the Crow's Nest Pass line of the Canadian Pacific Railway.

Pennsylvania's Governor Vetoes Extra-Crew Repeal Bill

The so-called "full-crew" repeal bill passed by the last Pennsylvania Legislature has been vetoed by Governor Brumbaugh. For the iron-clad mechanical rule fixing the sizes of crews the bill would have substituted authority vested in the Public Service Commission to decide each case on its merits.

Full-Size Steel Sections Shown at Bridge Company's Exhibit

In its exhibit at the Panama-Pacific International Exposition at San Francisco, the American Bridge Company shows not only chord sections of important bridges, but also column sections of many of the principal office buildings of the United States. During the past few years many such steel structures have been built by this company, and the sections exhibited are all from among those for which it furnished the material. All sections were built full size of steel.

The central and most important feature of this part of the exhibit, according to information received from Louis J. Affelder, assistant

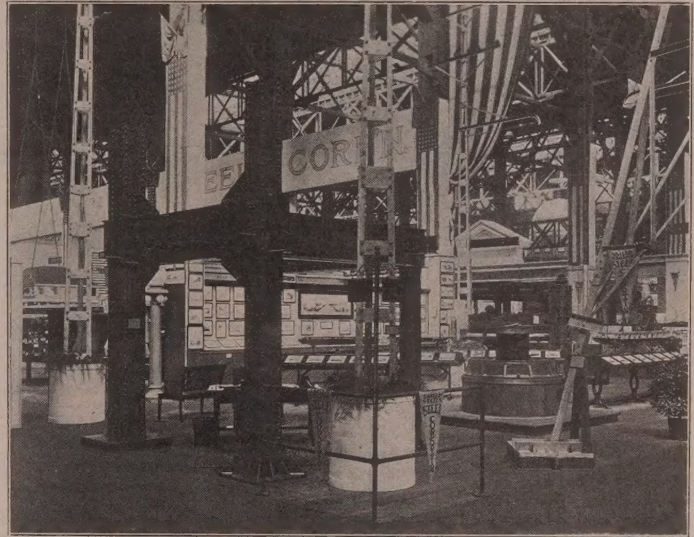
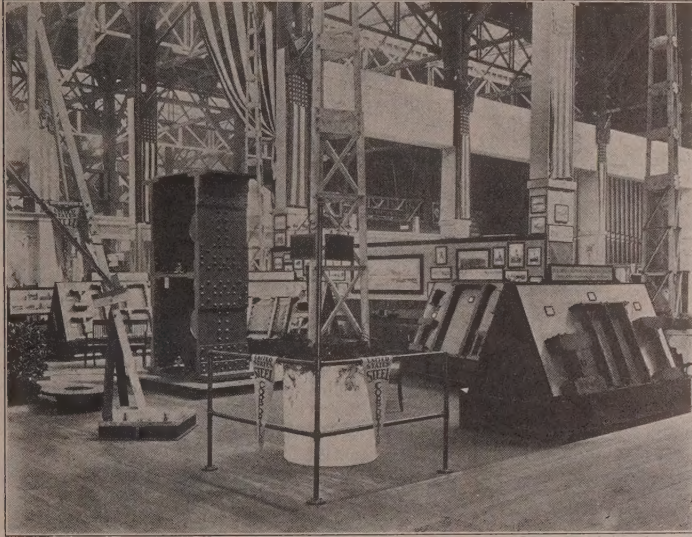
Forged tension members are also shown and eye-bars, loop rods, etc., in several sizes. An eye-bar which has been tested to destruction is shown in close proximity to the large Hell Gate section; it represents a test made to determine the strength of bars now being manufactured by the American Bridge Company for the new Quebec Bridge.

A transmission tower sixty-eight feet high surmounts the aisle. It is entirely built above the floor so as to show the special anchorage recommended by the bridge company. A turntable center is suitably mounted so that the conical rollers may be examined. A group of photographs of the many steel structures furnished and erected by the American Bridge Company at Panama forms a prominent part

Santa Fe to Solve Chicago Fruit Terminal Problem

\$500,000 Improvement Fits In with Wallace Plans
—Will Utilize \$3,750,000 of Idle Property in Industrial Heart of City

Provided that Chicago's city council will allow the Atchison, Topeka & Santa Fé Railway to close certain streets crossing its property near Twenty-second Street, that company proposes to construct a railroad fruit terminal which will handle all fruit shipments into Chicago, provide an interchange business with all lines and eliminate waste of time in spotting and inspecting cars. The project plans which have been completed will involve an in-



FULL-SIZE SECTIONS OF HELL GATE BRIDGE AND TYPICAL STEEL SKYSCRAPER CONSTRUCTION EXHIBITED AT PANAMA-PACIFIC EXPOSITION

division contracting manager for the company, is a 3-ft. length of the heaviest bottom chord section of the 1000-ft. Hell Gate arch, now being built across the East River, New York. This has the largest area of cross section of any bridge member built in this country—1376 sq. in. The main section without details weighs nearly 4700 lb. per lineal ft. The sections of other bridge chords were built in as short lengths as possible, and selections were made to illustrate the two, three and four-web types. Tie plates were used in lieu of lattice bars or angles.

An interesting study is afforded by the tower buildings, of which basement and roof columns were selected for contrast. These include the Woolworth Building and Metropolitan Tower in New York, the L. C. Smith Building in Seattle and the Union Central Life Insurance Building in Cincinnati. The basement column of the Woolworth Building has thirty-six times the cross section of the roof column. For all other columns, sections of the basement tiers were used. The largest and best known buildings in a locality were generally selected so that the exhibit would be of interest to the layman as well as the architect and engineer.

The exhibit occupies two spaces on opposite sides of the main aisles at the south end of the Palace of Mines and Metallurgy. The compression members described above are in one of these spaces. Opposite is a steel frame illustrating details of typical office building construction, a photograph of which is here reproduced. Two of the columns are constructed of plates and angles, one having cover plates and a standard splice to a stub of a lighter column above, and a steel slab footing. A third column is of the box type built of plates and channels and has a typical cast iron base. The fourth corner has a Carnegie H-section, showing its use as a light column. This and the light plates and angle column have riveted bases. A method of wind bracing by means of a plate girder with knees, spandrel sections, and various kinds of beams and column connections are shown.

of the exhibit. In all, the company fabricated and erected upwards of 70,000 tons of steel for the various structures at the Isthmus.

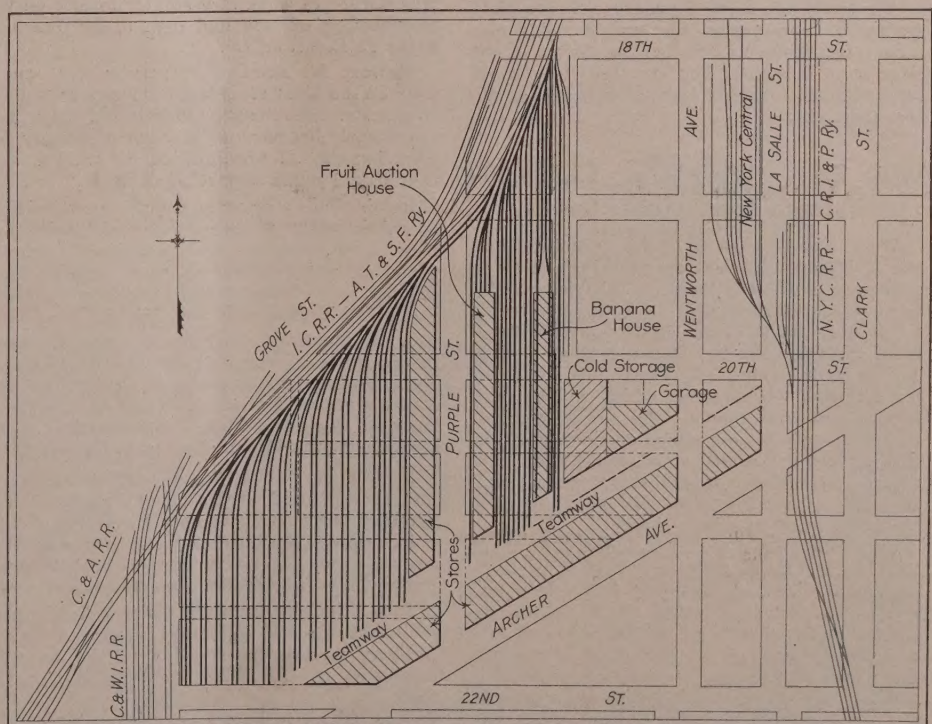
\$8,300,000 for Pennsylvania Roads

Governor Brumbaugh of Pennsylvania approved an \$8,300,000 appropriation for State highway work this week. As passed by the Legislature the sum available was to have been \$8,400,000.

vestment of \$4,100,000. The land on which the terminal will be built is valued at \$3,575,000 and has been owned by the company since 1907, although a large share was procured in 1887. It will include an area bounded by La Salle, Seventeenth, Grove and Twenty-Second Street and Archer Avenue.

Location Fits Wallace Plans

The plans are along lines similar to those suggested by John F. Wallace, chairman of the



PROPOSED FRUIT TERMINAL WILL HANDLE ALL SHIPMENTS INTO CHICAGO

Chicago Railway Terminal Commission, in a recent report, and the track layout fits in with his general scheme to alleviate Chicago's present congested terminal facilities. East of Clark Street the Santa Fé proposes to erect an L. C. L. fruit receiving station connecting with the Illinois Tunnel Company, which will allow shipments to be carried to merchants within the city limits.

The track layout permits the handling of 700 cars per day and provides for thirty team tracks and twenty-one storage and inspection tracks. It is expected that about 500 cars per day will be the average. The team tracks will be paved with some hard surface material. For fruits other than bananas, the one kind of fruit that is not auctioned off in Chicago, a fruit auction house 60 x 660 ft. in plan and costing \$150,000 will be erected. A banana shed, cold-storage house and garage, as well as sixty stores for rent to the fruit merchants, will also be erected.

The plans were prepared under the supervision of C. F. W. Felt, chief engineer of the Santa Fé, and have been approved by the largest auction fruit firm in the country. The ordinance before the city council was up June 15 and was referred to a sub-committee for investigation. As soon as it is granted work will be started by the railway company.

Southwestern Waterworks Holds Convention in Texas

The Southwestern Waterworks Association held its annual convention at Galveston, Texas, June 14-16. Among the papers were "Leakage from Cast-Iron Water Mains," by Joseph W. Ivy, of Kansas City; "Filtered Water Supply of the Canal Zone," by Guy Eldredge, of Fort Worth; and "Pneumatic Pumping as Applied to Wells," by D. H. Hunter. Alexander Porter, consulting engineer, told of the experiences during his recent visit to Havana.

It was voted to send E. L. Fulkerson, secretary, to the next annual convention of the American Waterworks Association in New York.

The following new officers were elected: President, Jesse Shaw, of Topeka, Kan.; vice-presidents, J. W. Lacy, of Brookfield, Mo.; L. H. Gray, of Lufkin, Texas; J. D. Hudgins, of Roswell, New Mexico; R. C. Trube, of Texas City, Texas; A. A. Haynes, of Texarkana, Texas; and C. C. Clothier, of Guthrie, Okla.

A motion was carried granting to associate members, representing the supply and equipment manufacturers, the full privileges of the floor at all meetings and the right to vote on all questions, formerly enjoyed only by the active members.

Will Start Work on \$3,500,000 Chicago Intercepting Sewer

Work will be started in the near future on the \$3,500,000 Calumet intercepting sewer by means of which the Sanitary District of Chicago proposes to divert all sewage entering Lake Michigan south of Eighty-seventh Street from the lake and the Calumet River and to discharge it behind the controlling works of the Calumet Sag Channel which will be built just east of Blue Island. The sewer, which is to be of concrete, horseshoe section, will take care of both dry weather and storm flow. Approximately 22 square miles of territory will be served at present. This will be increased to 29 square miles at a later date.

Bids called for June 24 included 4345 ft. of 11 ft. horizontal diameter and 7778 ft. of 13 ft. horizontal diameter conduit. Later bids will call for 24,600 ft. of 16½ ft. horizontal diameter and 12,000 ft. of outfall sewer of size between 16 and 18 ft. horizontal diameters. There will also be some miscellaneous work in smaller sizes in connection with the construction of a sewage pumping station which will handle 24 to 1000 cu. ft. per second and will probably be steam driven.

Personal Notes

N. L. Sanon has been appointed to an engineering position on the office forces of the New York State Railways at Rochester.

Charles Bostrom, general contractor, of Chicago, has been appointed building commissioner of that city, succeeding Henry Ericsson.

Horace E. Smith has been appointed county engineer of Okanogan County, Wash., to fill the vacancy caused by the death of George J. Gardiner.

W. J. Knauer, formerly inspecting engineer for the New York State Highway Commission, has been appointed superintendent of highways for Chautauqua county, N. Y.

J. H. Nuelle, chief engineer of the New York, Ontario & Western Railway at Middletown, N. Y., has been appointed assistant general manager in addition to his previous duties.

H. C. Phillips, valuation engineer of the Athison, Topeka & Santa Fé system, has been elected assistant general secretary of the Presidents' Conference Committee of the railroads.

Edward A. Lees, formerly connected with the J. L. Mott Iron Works, has been appointed assistant director of the Department of Public Health and Charities of the city of Philadelphia.

Stanley McCassy, until recently draftsman for the Morgan Engineering Company, of Dayton, Ohio, is now connected with the valuation department of the Rock Island Railroad at Chicago.

L. M. Mitchell has been appointed engineer and inspector on the concrete viaduct being constructed at Marshalltown, Iowa, by the Chicago Northwestern Railway and the Minneapolis & St. Louis jointly.

W. A. Howell is connected with the Hanscom Construction Company, of Boston, in the capacity of superintendent of construction on the \$65,000 waterworks contract that company is starting work on at Shrewsbury, Mass.

James W. Follin, formerly teaching assistant in civil engineering, in charge of the sanitary experiment station at the University of Michigan, has been appointed assistant engineer on the forces of the State sanitary engineer of Michigan.

S. S. Seiler, formerly U. S. junior engineer on the construction of lock and dam 1, on Big Sunflower River at Murphy, Miss., has been transferred to work of a similar nature on the construction of lock and dam 3, on Ouachita River at Riverton, La.

Stewart M. Marshall, formerly chief engineer of the Cambria Steel Company at Johnstown, Pa., has become associated with the Southwark Foundry & Machine Company, of Philadelphia, as manager of its turbine and centrifugal pump departments.

Ralph Folks, formerly deputy commissioner of public works of the Borough of Manhattan, New York City, has been appointed commissioner of public works of that borough, succeeding E. V. Frothingham, whose resignation was noted in these columns, May 8.

J. H. Merriam, formerly division engineer in charge of reconstruction of the Chicago, Burlington & Quincy Railroad bridge over the Platte river at Ashland, Neb., is now resident engineer in charge of the reconstruction of the bridge over the Missouri river at Kansas City.

Prof. A. N. Talbot, the well-known authority on concrete, and professor of municipal and sanitary engineering in the University of Illinois, received the honorary degree of doctor of science from the University of Pennsylvania, Philadelphia, at the commencement last week.

J. S. Findley, formerly construction superintendent for the Missouri, Kansas & Texas Railway on the construction of the recently completed office building of that company at Parsons, Kan., has been transferred to Canadian, Okla., to be masonry inspector on the 1000 ft. bridge being constructed over the Canadian River at that point.

George D. Halsey, who recently completed a course in co-operative civil engineering at the University of Cincinnati, has been appointed co-ordinator at the Georgia School of Technology to put co-operative courses into operation there, similar to those in the University of Cincinnati.

Irving W. Stoddard, U. S. surveyor, who has been making surveys of the grant land of the Atchison, Topeka & Santa Fé Railroad in Arizona for the General Land Office, U. S. Department of the interior, has been transferred to the drafting division of the general surveyor's office at Olympia, Wash.

T. H. Davis, chief engineer of the Long-Bell Lumber Company of De Ridder, La., is at present engaged in surveying and classifying lands belonging to that company and allied companies in the State of Louisiana, preparatory to their sale and development for agricultural and stock raising purposes.

Charles H. Richards, recently in charge of the San Fernando Valley survey for the flood control commission, and who previously was connected for several years with the construction of the Los Angeles Aqueduct, has opened an office in the First National Bank Building, Van Nuys, Cal., for the purpose of engaging in a general engineering practice.

S. T. Henry, second vice-president of the McGraw Publishing Company, Inc., and formerly Western editor of the Engineering Record, has been appointed by Secretary of the Treasury McAdoo a member of the committee of the Pan-American Financial Conference which will have charge of the visits of American bankers and business men to Central and South American countries.

H. J. Brunner, consulting engineer, of San Francisco, is doing the structural engineering work on the Shredded Wheat Company factory at Oakland, Cal., of which Hobart & Cheney are the architects. The work will require 450 tons of reinforcing steel. He is also consulting engineer on the projected 750-ft. span suspension bridge over the Eel River, near Scotia, Cal.

Chester Allen, formerly assistant professor in civil engineering at Pennsylvania State College, has been appointed professor in charge of the civil and municipal engineering courses at Pennsylvania College, Gettysburg. He was graduated from the Massachusetts Institute of Technology in 1905 and engaged in active practice in the Middle West until 1911, when he took up teaching.

Walter P. Houston, formerly inspector of concrete aggregates for the New York State Public Service Commission, First District, at Peekskill, N. Y., has been appointed to a position on the forces of the Interstate Commerce Commission, Division of Valuation, and is, at present, connected with the party which is evaluating the Boston & Maine Railroad, Western Division to Portland, Me.

Charles McKercher, formerly assistant engineer on the forces of the Cuba Railroad, has accepted a position as engineer in charge of the construction of three sugar mills in Cuba and the railroad location and construction for the development of the Florida plantation, Camaguey Province, Cuba, for Dibert, Bancroft & Ross, manufacturers of sugar mill machinery of New Orleans, La., and Camaguey, Cuba.

Charles S. Shaughnessy, who has been studying the sanitary drainage of Jamaica Bay for the Borough of Queens, New York City, has been appointed engineering examiner by the Municipal Civil Service Commission of New York City. He was graduated from Harvard University in 1901, and after two years spent as instructor, was appointed rodman on the engineering forces of the Pennsylvania Railroad and, later in the same year, instrument man for the sewer department of the city of Boston. He attained the grade of assistant engineer in this service and resigned to become assistant engineer for the Board of Water Supply of New York City on the Catskill Aqueduct.

A. T. North, formerly contracting manager of the Central Engineering Company of Davenport, Iowa, and consulting engineer for the Yellow Pine Manufacturers Association, has become associated with the Abraham Lund Company, general contractors of Chicago, and will be in charge of the company's engineering and estimating departments. He was graduated from the University of Illinois in 1885 and, after serving as draftsman with Adler and Sullivan, architects of Chicago, for a year, served as engineer, estimator, superintendent and chief engineer for various iron works until 1896, when he was appointed superintendent of construction for Arthur Johnson & Brother on the construction of the 16-story Chemical Building at St. Louis. He was appointed chief engineer of the western department of the National Fireproofing Company in 1905, and contracting manager of the Central Engineering Company in 1913.

Alger C. Gildersleeve, formerly chief engineer and general manager of the Alamo Construction Company, of New York City, and, more recently, engineer for the Degnon Contracting Company on the construction of the Loose-Wiles Biscuit Company building and the design and layout of the yards and tracks of the Degnon Realty & Terminal Improvement Company in Long Island City, N. Y., has been appointed secretary of the Chamber of Commerce of Bayonne, N. J. This city is contemplating the construction of a bridge across Newark Bay to Elizabeth, a new method of sewage disposal and other new projects. He was graduated from Columbia University in 1890, and has been engaged in engineering practice and contracting work in this country, Mexico and Cuba. As consulting engineer for the Snare & Triest Company of New York City and Havana, Cuba, he supervised work to the value of \$1,250,000 in connection with construction of the subway connection to Williamsburg Bridge, New York City.

Obituary Notes

Daniel R. Bissell, construction engineer for the San Francisco-Oakland Terminal Railways, died on June 9 at his home in Alameda, Cal., after a short illness.

Dr. William L. Breyfogle, one of the builders and first president of the Chicago, Indianapolis & Louisville Railroad (The Monon Route), died last week in Hillsborough, a suburb of San Francisco.

Charles L. Haydock, assistant engineer on the Missouri Pacific Railway, was drowned at Leavenworth Junction, Kan., June 19, while superintending the construction of willow mats to prevent the Missouri River from undermining the railway tracks at that point.

John Drew Allen, formerly with the Taylor-Wharton, Jr. & Company in charge of their Seattle office, was killed May 16 in an accident while making an inspection of rails received by the Salt Lake & Ogden Railway, at Salt Lake City. Mr. Allen was born in 1881 and entered the employ of the Pennsylvania Steel Company in 1902 as secretary to the general manager. In 1908 he was transferred from the Philadelphia sales office to Chicago, where he continued until 1914, when he went to Seattle. He was a member of the Chicago Engineers' Club.

Loomis E. Chapin, consulting engineer, of Pittsburgh, Pa., and Canton, Ohio, died in Canton, June 19. He was born in 1859 and graduated from the University of Michigan in 1883. His first engineering connection was with the Wheeling & Lake Erie Railroad as assistant engineer of construction. In 1887 he was appointed principal assistant city engineer of Toledo, Ohio, and had charge of the construction of the Cherry Street bridge, a work costing \$250,000. He was appointed city engineer four years later and also engaged in private practice as consulting engineer, in which capacity he designed water-works and sewerage systems for many cities and towns in Ohio and neighboring States.

New Instrument Tests Sands Quickly in the Field

Portable Apparatus for Granularmetric Analysis Is Designed to Control Quality of Construction Materials

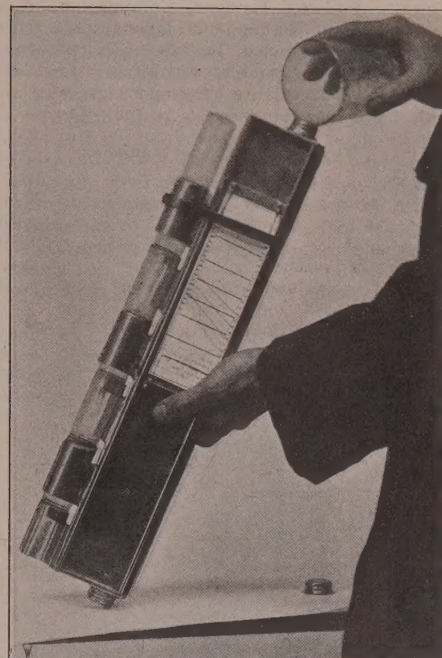
The testing of sands for concrete work has been stated by Cloyd M. Chapman and Nathan C. Johnson, the authors of the series of articles which is concluded in this issue of the Engineering Record, to be possible of division into two classes of work. The first class should be performed in a properly equipped laboratory to establish the quality of the sand and the proportions in which it should be used. The second class of work should properly be performed in the field to insure uniformity of the various shipments as received. This field control is best effected by making frequent granularmetric analyses and comparing results of such tests with a standard chosen by the testing engineer.

The present method for making such granularmetric analyses was shown to be cumbersome and slow, and to simplify and hasten the procedure a portable self-contained instrument was devised. As may be seen from the accompanying photographs, it consists essentially of a rectangular metal casing, within which is fastened a series of slanting screens of the sizes desired. The upper sides of these screens register with passageways borne by the top of the casing; and screwed into these passageways are a series of glass vials. Along one side of the casing run two light rods, which carry a sliding metal platen for holding the record sheet and a sliding indicator.

Operation of Instrument

In the operation of this instrument a sample is taken by filling a small measure with sand at the sand pile, or at the car, or barge, or at the deposit itself, as may be desired. The sand in this measure is introduced into the casing at one end, together with sufficient water to bring the level to an indicated point. With the glass vials uppermost, the instrument is then given a slow, reciprocating motion in the hands, the number of impulses necessary being dependent upon the fineness of the sand, finer sands, as would be expected, passing less readily through the several inclined screens than do those of coarser sizes.

By means of this reciprocating motion the water in the container is thrown into waves, which progress lengthwise in the container, carrying the sands upon the several screens in much the same manner as natural waves carry

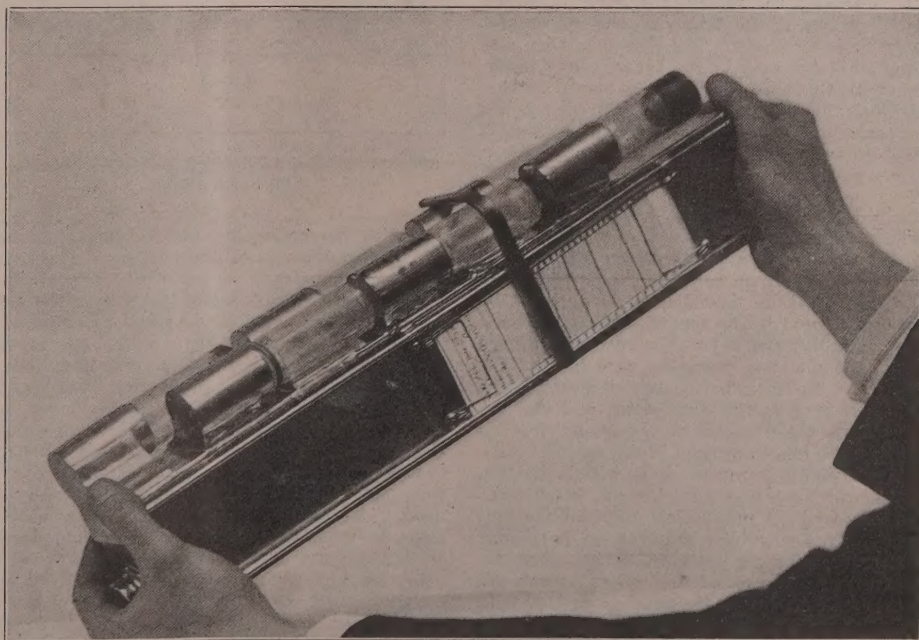


THE SAND SAMPLE AND WATER ARE FIRST INTRODUCED INTO THE END OF THE CASING

sands up a sloping beach and effecting their more-or-less complete gradation.

As before indicated, fine sands are sieved less readily than are coarse sands. To effect the complete gradation of these finer materials, a bulb (not shown in the photograph) attached to one end of the instrument is pressed in such manner as to give a quick upward impulse of the water, which causes a succession of momentary liftings of the materials on the screens, but without the tendency to run backward through the coarser screens that is present when waves are induced by the reciprocating motion first applied. During this impulsing by the bulb the instrument is held in one hand in a slanting position, so that gravity, coupled with the surging of the water, may carry the several materials through their respective screens.

After about 20 or 30 impulses have thus been applied to the bulb the instrument is turned over on its longitudinal axis, with continued pressing of the bulb. This causes the materials retained by each screen to be washed into the passageways with which the screens

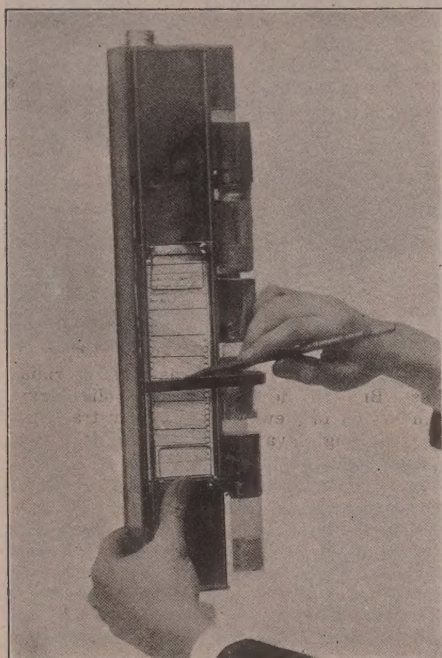


AFTER RECEIVING SAMPLE INSTRUMENT, WITH GLASS VIALS UPPERMOST, IS GIVEN A SLOW RECIPROCATING MOTION TO CREATE WAVES IN WATER

register. The instrument is then turned into a vertical position, when the materials collected in the passageways are washed into the six bottles, so that there is obtained a grading of the sample into six sizes.

Two Difficulties Overcome

So far as the procedure has gone, two difficulties in the usual sieving apparatus have been overcome. The first is lack of portability; the second is the necessity for drying, for in the place of absolute dryness has been substituted absolute wetness—a condition much more



PENCIL LINES ON RECORD SHEET INDICATE SAND GRADATION PERCENTAGES

easy and incomparably more rapid of production, especially under field conditions.

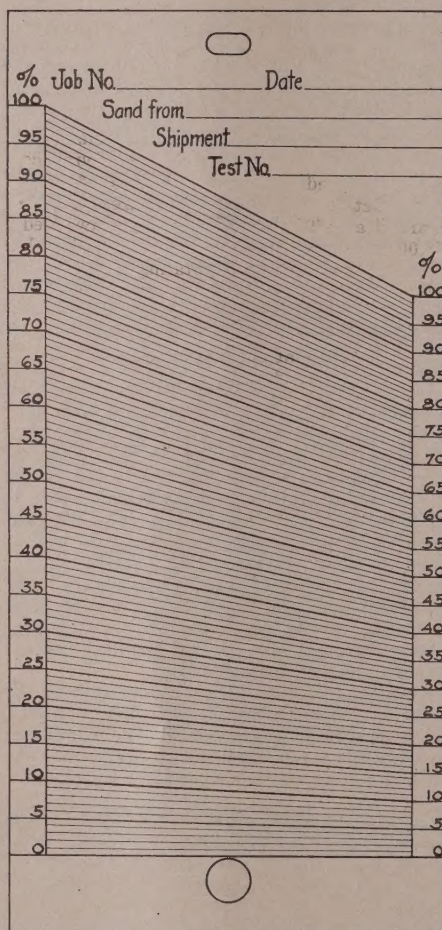
It now remains to determine the percentages of the several sizes and to secure a record of the analysis. This is accomplished by placing on the platen the special record sheet shown in the sketch. By means of carbon paper, this is made in duplicate, registry of record sheets being assured by holes at either end, engaged by proper pins on the platen.

In obtaining the record, the index is placed at the bottom of the first vial, the instrument being held vertically. The platen is then slid along until the zero of the record sheet registers with the index. With the platen in this position, the index is moved until it reaches the top of the sand in the first vial. A line is then drawn across the record sheet with a pencil, as shown in the above photograph.

Graphical Records Are Made

This done, the index is moved to the bottom of the second vial and the platen slid upward until the line drawn registers with the index. The index is then moved until level with the top of the sand in the second bottle. A pencil line is again drawn across the record along the index, the distance from the zero line on the record to the first pencil line indicating the height of sand in the first bottle, and the distance from the first line to the second line indicating the height of sand in the second bottle. This procedure is repeated for all six bottles, so that the height of sand in each is indicated on the record. A mechanical addition has thus been performed which requires no particular skill or training on the part of the operative. As many duplicates of the record as are desired, can be had at the one operation, with identifying names and numbers written in spaces provided at the top, and it is further obvious that the percentages of each grade of sand may be read directly by providing a proper diagram.

In preparing this diagram, a property of sands before mentioned, namely their increase or decrease in volume according to their fineness, and moisture content, had to be taken into consideration. Since the measure is filled with sand directly from the pile, provision has to be made for variation in its absolute volume. To this end, a variation of 25 per cent in the height of the right and left-hand margin ordinates of the printed record sheet is provided, each ordinate being divided into 100 parts, to represent percentages, with the like divisions of each ordinate connected by sloping lines. It is evident, therefore, that there is an allowable variation of 25 per cent in size of sample, since the record is of such height that the last pencil line drawn will cut the 100 per cent line at one point or another. If through this point a vertical line is drawn, the percentage of material retained on any screen may be read from the record by finding the intersection of this last



SPECIAL RECORD SHEET FOR MARKING RESULTS OF SAND TESTS

line with the index line, and reading right or left on the percentage line passing through or nearest this point.

By these several means, therefore, the requirements of portability, accuracy, elimination of the requirement for a skilled operative, quick performance duplicate records and allowable variation in size of sample have been met.

Interpretation of results is accomplished by the following simple means. It is understood to be essential that the testing laboratory shall first establish by thorough tests the proportions in which any given materials shall be used. Any variation in the granulometric analysis will tend to vary these proportions. In this instrument, the allowable limits of variation for each grade of material are indicated on the record sheet in red. If, therefore, the percentages read from the pencilled index lines fall within these limits, the material may be accepted as satisfactory. If any fall outside, the seriousness of the variations must be taken into consideration, being referred when

necessary to higher authorities through duplicates. It is understood, of course, that in thus determining the worth of a shipment, several tests should be made from each lot—an accomplishment possible in a short space of time, because of the rapidity with which the tests may be performed. In this way, an entire job may be kept under close control.

It is also evident that a washing test for silt, clay, or loam is performed by this instrument at the same time the grading is accomplished. Although the distribution of such materials is general throughout each of the six vials, its quality may be approximately judged by the extent of such deposits, or by the persistent turbidity of the water, and supplementary examination conducted in the laboratory if it be deemed necessary. A further field of usefulness is offered in materials surveys, either in choosing sand for concrete, or sand for filter beds, or other purposes. Further the easy making of the record sheets permits an accurate report of such surveys to be made, without the expenditure of much time, or the carrying of elaborate paraphernalia; and the testing of a considerable number of samples taken at different points in the deposit permits a close check on its uniformity.

The manufacture and sale of this instrument is in the hands of The Concrete Appliances Company, Inc., of 100 Broadway, New York.

Small Compressor for High Speeds

A small, steam-driven air compressor designed along the same lines as the company's former small, steam-driven compressors, and which is claimed to embody many improvements, with an increased efficiency in the air end and a decreased steam consumption has been put on the market by the Ingersoll-Rand Company, of 11 Broadway, New York City. It is equipped with the Ingersoll-Rogler air valve, balanced piston steam valves, automatic splash lubricator and automatic cut-off control, which, in turn, is supplemented by an air unloader. The latter, it is claimed, assures economy of operation and possesses the high degree of automatism which is so desirable in a small compressor designed for severe duty. It is of enclosed construction and equipped with removable covers.

Business Notes

The Holt Manufacturing Company, of Stockton, Cal., has been awarded a grand prize at the Panama-Pacific Exposition for its caterpillar tractor.

The Hughes Specialty Well Drilling Company, with main offices located at 96 Ashley Ave., Charleston, S. C., has moved its Atlanta, Ga., office from 69 Bedford Place to the Empire Building.

Trade Publications

The following companies have recently issued trade literature:

Pittsburgh-Des Moines Steel Company, Pittsburgh. Booklet, 3½ x 6 in., 32 pages, illustrated. Describes briefly several designs of steel tanks of large capacity.

J. G. White Companies, 43 Exchange Place, New York. Pamphlet, 8¼ x 11¼ in., 12 pages. The annual report to the stockholders, showing the condition of these companies at the end of the year 1914.

Chicago Pneumatic Tool Company, Fisher Building, Chicago. Bulletin 34-U, 6 x 9 in., 24 pages, illustrated. Erecting and operating instructions for type N-SO oil-engine driven air compressors, with detail sketches and list of repair parts.

Concrete Engineering Company, Omaha, Neb. Catalog, 6 x 9 in., 48 pages, illustrated. Meyer Steelforms for concrete in building construction. Includes numerous tables on slab and beam loadings and stresses, based on the straight line formula.